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# Towards Higher Productivity

The British Steel Founders' Association has achieved a reputation for acquiring information and for making this easily accessible in forthright terms. Thus, at a productivity convention they organised at Ashorne Hill last week-end, a method—novel to us—was used for quickly establishing interim progress. There were six sessions, covering nearly every phase of steel-foundry practice. Strictly from the angle of potential productivity, a lecture of an hour's duration was given. Then the members—directors, managers, technicians and workpeople (totalling we should imagine about 120)—were divided into ten groups, based on the last digit of their room numbers. The subject under discussion was then reviewed by the groups under conditions which made expression of opinion, even by those who are constitutionally unable to speak in public, a quite natural and easy effort. Returning to the conference hall, each group reported as a group the consensus of opinion, supplemented by personal views. By this system, a real cross-section of the opinion of the industry was gained, instead of the usual personal views of accomplished speakers. It was early established that the production of one bad steel casting is harmful to the whole industry. Therefore, there should be intense co-operation to institute the best practice in all foundries, and moreover steps are to be taken to ensure this.

The system of discussion outlined brought to light, in connection with the first session devoted to melting practice (and, virtually, electric melting practice), that increased power for each furnace to implement the Report's recommendation, might be more easily attained by the following means:—As one or more of the larger furnaces becomes re-equipped with new transformers of greater capacity, those discarded should be made available for firms using smaller-tonnage furnaces, and so on right down the line. In these days of electricity cuts and power shortage, however, pressure will have to be brought to bear on the supply authority before much progress can be made. Naturally enough, in connection with "feeding and gating," the age-old question of co-operation with the designers was raised and squashed by an uncontradicted statement that for the past twenty years, where modifications in design had been sought, on receipt of an order, there had never yet been a case of unreasonable refusal. The importance of "sand practice" rightly became associated with the fettling shop, as it was the latter which was usually the "bottle-neck." We think a useful opportunity was missed in this session, as no information was gleaned as to whether the whole or only a part of the industry was imposing a rigorous sand control, yet the proportion is believed to be high.

It was in connection with "mechanical aids" that the interest rose to a maximum. Here, the chairman asked the groups to estimate by what amount, assuming wholehearted enthusiasm by everybody, productivity could be increased (*a*) by using existing plant to its best performance and (*b*) by installing a reasonable amount of new equipment. It was during the discussion on this subject that we learnt that in one foundry, agreement requires that only moulders—meaning, presumably, skilled men—should operate the moulding machines. We

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### *Towards Higher Productivity*

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asked whether such an arrangement would remain in force if push-button-controlled machines were installed! A continuance of such practice obviously kills skill. We heard the repetition of the argument about unemployed men at the gates of the factory because of the installation of machinery, by people who remembered the number of hostlers, stablemen and harness makers who were put out of work in the road-transport industry by the coming of the motor car and forgot what a vastly-increased number of people had thereby found employment. However, the spirit of the Convention discarded all these old-fashioned notions and the following resolution was carried unanimously:

> We, the delegates to this convention, representing all kinds of workers in the steel-founding industry, each and severally pledge ourselves, unreservedly, without fear or favour, to constant endeavour to increase the productivity of our industry.

## Scientific Films Census

In connection with the information service of the Scientific Film Association, a national survey is being made of makers, owners and users of scientific and similar films. Although information has been collected already from over four hundred scientific-film makers and distributing agencies, including the major companies, it is believed that there are many more whose names and films are known only to a limited number of people. The Association earnestly wishes to bring up to date its records of documentary, instructional, educational and scientific films, so that it may be in a better position to answer the many inquiries which are made to its secretariat. The records which are now being compiled will form an invaluable reference library of catalogues, lists and data sheets.

It has been found in some cases that the private producer of individual films is reluctant to make available the kind of information now being sought, for fear of being embarrassed by a large number of inquiries, arising out of the publication of data about his film or films. When desired, however, the Association is prepared to treat such communications as confidential for its own records. The kind of statement which is now needed should give the maker's name and address, the title of the film, its gauge and length or running time, and preferably a brief synopsis. The rapidly-growing importance of scentific films has made a survey of this kind imperative, so that in conducting such an inquiry—which has never been attempted previously on this scale—the Scientific Film Association's information—services department believes that it is going some way towards meeting a very real and urgent demand. Further details of the work of the Association may be obtained from 4, Great Russell Street, London, W.C.1.

## Forthcoming Events

NOVEMBER 28.

**Junior Institution of Engineers**

*Sheffield and District Section*:—"Some Inventions of Sir Henry Bessemer," by G. Baker, O.B.E., M.I.Mech.E., at the Sheffield Metallurgical Club, 198, West Street, Sheffield, at 7.30 p.m.

NOVEMBER 29.

**Institute of British Foundrymen.**

*Slough Section*:—"Some Notable Aluminium Alloy Castings," by A. R. Martin, at the Lecture Theatre, High Duty Alloys, Limited, at 7.15 p.m.

**Institution of Production Engineers.**

*Western Section*:—"A New Conception of Britain's Energy," by Sir Claude D. Gribb, C.B.E., D.Sc., M.E., F.R.S., M.I.P.E., at the Physics Theatre (Royal Fort), at 6 p.m.

NOVEMBER 30.

**Institute of British Foundrymen.**

*London Branch*:—"High Productivity and the U.S. Steel Foundries," by F. A. Martin, O.B.E., at the Waldorf Hotel, Aldwych, London, W.C.2, at 7.30 p.m.

**Institution of Production Engineers.**

*Shrewsbury Sub-section*:—"Corrosion of Metals," by G. T. Peat, at the Technical College, Shrewsbury, at 7.30 p.m.

DECEMBER 1.

**Institution of Works Managers.**

*Bristol Branch*:—"Foremanship," by F. E. Chappell, at the Royal Hotel, Bristol, at 7.15 p.m.

**Institute of Vitreous Enamellers.**

*Midland Section*:—"Manufacture of Enamelling Steel," by W. H. F. Tickle, at the Chamber of Commerce, New Street, Birmingham, 2, at 7.15 p.m.

**Institute of Industrial Supervisors.**

*Smethwick Section*:—"Polarised Light," by C. Bridgewater, at the Chance Technical College, Crocketts Lane, Smethwick, at 7 p.m.

**Institute of Metals.**

*Birmingham Local Section*:—"Age-hardening," by Marie L. V. Gayler, D.Sc., at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6.30 p.m.

**Association of Bronze and Brass Founders.**

Informal meeting, at the Clarendon Restaurant, Hammersmith, London, W.6, at 1 p.m.

DECEMBER 2.

**Institute of Production Engineers.**

*West Wales Sub-section*:—"Quality Control," by Dr. B. P. Dudding, M.B.E., Ph.D., at the Civic Buildings, Swansea, at 7.30 p.m.

DECEMBER 3.

**Institute of British Foundrymen.**

*West Riding of Yorkshire Branch*:—"The Production of Castings for Internal-combustion Engines," by H. Haynes and C.R. van der Ben, at the Technical College, Bradford, at 6.30 p.m.

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IT IS WITH REGRET that we record the death on November 20 of Mr. J. P. D. Coleman, a director of Wild-Barfield Electric Furnaces, Limited, from 1933 until his retirement in 1948. He started his long connection with the electrical industry when he joined the National Telephone Company in 1896, and served under the late Mr. E. P. Barfield, an association which was almost continuous until the latter's death in 1938. During the last war, he volunteered and served for a short time with the R.N. motor fishing vessels. In 1945, he gave up active day-to-day participation in the business, but remained on the boards of Wild-Barfield Electric Furnaces, Limited, and G.W.B. Electric Furnaces, Limited, until, on account of ill-health, he resigned his directorships in 1948.

# Swords to Ploughshares

## *Post-war Development in East Anglia*

*By A. R. Parkes*

Shortly after the cessation of hostilities and the reversion from emphasis on munitions of war to concentration on peace-time activities, it became obvious that the existing iron foundry of Ransomes Sims & Jefferies, Limited, Ipswich, could no longer cope with the expanding demands of the firm's agricultural-implement business. There was no suitable site in the town proper, so a large plot of land in open country was acquired, some 2½ miles distant from the main works. A licence to build a new foundry was secured in 1946.

### Design and Layout

It might be thought that with the passage of time, mechanised or semi-mechanised foundries would, by exhaustion of possibilities, fall into a series of somewhat stereotyped units according to size and type of product. As more and more are built, however, it becomes abundantly clear that this will never be the case. Quite apart from the evolutionary character of the improvement which is continually going forward in foundry layout and plant, there are, in each rebuilt foundry, inherent special features of production. These cherished, well-tried existing methods, perhaps unique to a given concern, frequently are adaptable to mechanisation only so far as conforms to the elimination of wasteful effort and are bodily carried forward as a part of the new enterprise. The Nacton Foundry, the name given to the project which has recently come into operation, is no exception to this rule; much of the production scheme is well-tried and proved. Labour-saving devices have been introduced only where they show a direct economy and not because there is any virtue in mechanisation *per se*. The design and layout has been largely a domestic concern, embodying, in the main, well-established principles. That this was, for the case in point, the correct method of progress is reflected in the success both in output and cost figures which has been so quickly achieved.

An aerial view of the buildings, which cover approximately 130,000 sq. ft., is shown in Fig. 1. A concrete approach road, half-a-mile long, connects with Nacton Road; railing sidings from the Ipswich-Felixstowe line are taken *via* a weighbridge to the stockyards (these are served by a private diesel locomotive); additionally, there is access by footbridge over the railway from the Ipswich-Felixstowe road. The buildings are of steel-framed brick and asbestos-sheet construction with ample side- and roof-glass and adjustable roof ventilators. As will be seen from Fig. 2—a basic floor plan—the foundry proper is divided into two main sections. These cover ploughshares in bays E, F, G, and H, each 45 ft. span by 150 ft. long and 18 ft. to the eaves, and general-castings production in bays A, B and C. The latter are 45 ft. span by 275 ft. long; bay A has a covered extension 125 ft. long, the whole being 23 ft. 6 in. to eaves and served by two 5-ton travelling cranes; B and C are 18 ft. to the eaves.

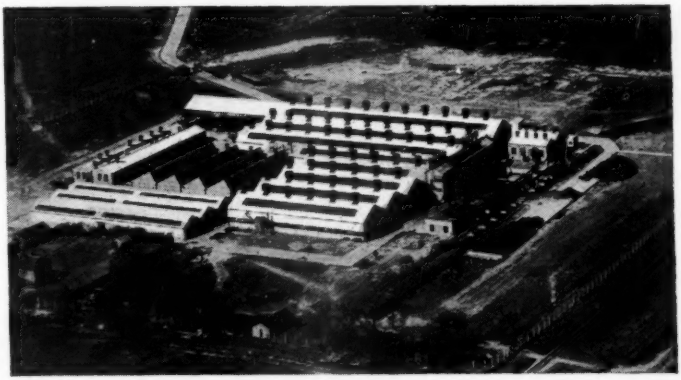

FIG. 1.—AERIAL VIEW OF THE NACTON FOUNDRY TAKEN FROM THE NORTH-EAST.

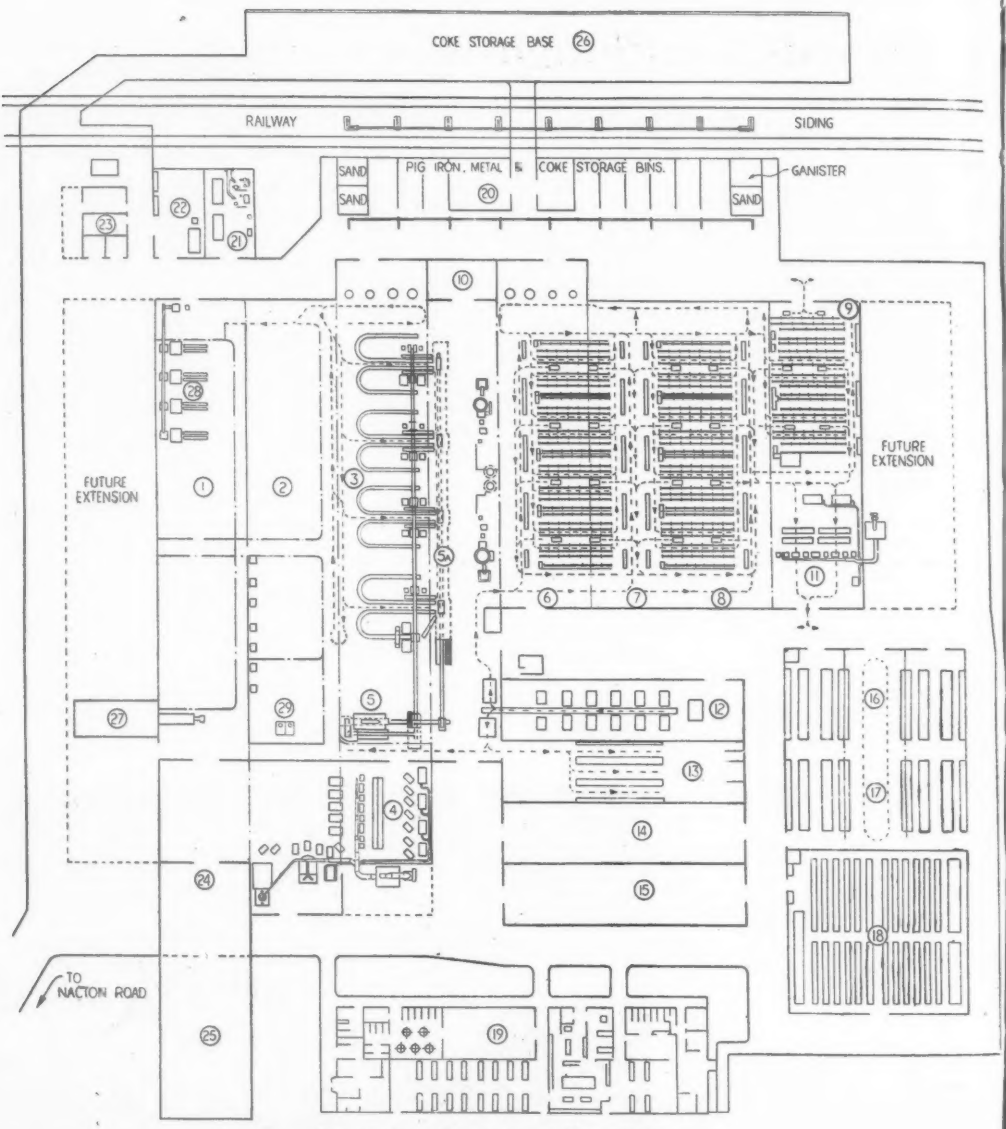


FIG. 2.—PLAN VIEW OF THE NACTON FOUNDRY.

*(For Key to the numbered sections see foot of facing page.)*

FIG. 3.—GENERAL VIEW OF ONE OF THE PLOUGHSHARE BAYS. RACKS OF CORES ARE IN THE BACKGROUND.

### Ploughshares

About 60 per cent. of the production by weight is of ploughshares. These are made to several different designs and the methods have remained for the most part unchanged over a long period. The moulds are, generally, of two types consisting either of a chill base with a sand top part or two two sand (top and bottom) half moulds with "cast-in" chills in the bottom half to chill the wearing edges only. The sand moulds are produced from specially-designed squeeze-type moulding machines of the firm's own design and manufacture which back onto rows of stands. These stands, consisting of double angle-iron rails, support (at about 2 ft. high) banks of about 30 to 35 moulds. For pouring, the 'share moulds are placed in a sloping position on the stands and are run from single ingates. The rows are traversed by metal-carrying ladles supported from above on one-way-only runways. Adjacent to the mould stands are similar supports at the same height for the weights. Moulding, placing, coring and knocking-out are, essentially, one-man operations, but it has been proved that the outputs achieved cannot be bettered by further mechanisation and that the series of synchronised operations thus performed by each man do obviate some monotony from his job. Production per man, per unit floor-space and (not least important) per £1 capital expenditure are high and flexibility over the enormously-wide range of patterns is secured. After the knock-out, castings are placed between the lines in stillages which are collected by electric truck. Sand supply is from brick-built "tubs" which are replenished periodically. This section is illustrated by Figs. 3 and 4.

### General Castings

The general-castings section, devoted to castings up to 10 cwt., has been more highly mechanised so far as sand supply, mould conveyance and knock-out are concerned. For example, the light-castings bay consists of eight independent double-loop gravity roller conveyors each serving a pair of moulding machines and abutting on a knock-out to each pair of double loops. Sand is taken from shovel-out, 4-ton capacity hoppers close to the machines, filled from a common sand system by overhead belts and ploughs. Pouring is from a ladle carried on an overhead runway between two sections and moulds are knocked out at the end of the loops, the empty boxes returning on the conveyor leg. Fig. 5 shows the general arrangement of a light-castings loop and Fig. 6 a specially-developed stripper machine for lawn-mower land rollers, which are made in this section.

*Key to the Numbered Sections in Fig. 1, Plan View of Nacton Foundry (on facing page).*

| Section. | Description. |
|---|---|
| 1. | Bay A: Heavy castings. |
| 2. | Bay B: Medium castings. |
| 3. | Bay C: Light castings. |
| 4. | General fettling shop. |
| 5. | Sand - preparation plant. |
| 5A. | Knock - out plant (Bay D). |
| 6. | Bay E: 'Share moulding. |
| 7. | Bay F: 'Share moulding |
| 8. | Bay G: 'Share moulding. |
| 9. | Bay F: 'Share moulding. |
| 10. | Cupola house. |
| 11. | 'Share fettling shop. |
| 12. | Core shop. |
| 13. | Core stores. |
| 14. | Metal-pattern shop. |
| 15. | Wooden-pattern shop. |
| 16. | Metal-pattern shop. |
| 17. | 'Share-pattern shop. |
| 18. | Wooden-pattern shop. |
| 19. | Amenities block. |
| 20. | Raw-material bins. |
| 21. | Compressor house. |
| 22. | Electric charging station. |
| 23. | Electric sub-station. |
| 24. | Despatch department. |
| 25. | Box storage. |
| 26. | Coke storage. |
| 27. | Mould-drying stove. |
| 28. | Heavy mechanised plant. |
| 29. | Brass foundry. |

FIG. 4.—OPERATOR POURING BANKS OF PLOUGHSHARE MOULDS FROM LADLE CARRIED ON OVERHEAD MONORAIL.

### Sand Plant

From the knock-out, system sand is carried underground to the conditioning plant shown in Fig. 8. This consists of a water spray, a worm mixer, an overband magnetic separator, vibratory screen and aerator, through which the sand passes in turn to a 40-ton storage hopper, whence it is redistributed to the overhead system. Dust and fume extraction units, made by Bivac Air Company, Limited, are fitted at the knock-outs and the vibratory screen. The whole of the sand plant was supplied by Stone-Wallwork, Limited. Advantages claimed for the large-capacity, shovel-out, tapered hoppers are absence of sticking and provision of a reserve supply against contingencies and better tempering of the sand, by reason of the time lag before re-use. Local yellow sand is used as make-up sand to replenish that lost with the castings, a state of balance being achieved to secure adequate moulding properties for the system sand.

Bay A is devoted to the production of larger castings and this section is yet to be completed. The equipment includes two Pneulec "Herman" 1,500-lb. machines, an independent sand plant, mould-drying stoves and overhead cranes. The covered extension to this bay, also served by the crane, is at present used as a box-part store.

### Melting Plant

The melting plant and its *modus operandi* at this foundry is unique within the experience of the writer. No fewer than eight cupolas (part shown in Fig. 9) for a total metal output of 220 tons per week are installed. The reason for this unusually large number of furnaces for a quite modest hourly metal demand lies in the duplex method of melting adopted for the wide range of metal compositions that are in use. For the 'share foundry, two distinct metal compositions are produced throughout the day from two separate cupolas. In the ladle, these two metals are mixed in exact proportions to suit the particular job on hand. Mixing is controlled by chill tests taken on the spot in apparatus shown diagrammatically in Fig. 7. It is the flexibility combined with precision thus gained by duplex melting which makes it possible to guarantee the exact chilling properties to suit any section or mass in the range of shares produced.

FIG. 5.—VIEW OF THE DOUBLE GRAVITY-CONVEYOR LOOPS IN THE MECHANISED SECTION FOR THE SMALLER CASTINGS.

For the rest of the foundry, direct melting or duplexing with 'share or alloy metal is used according to the exigencies of the demand. Normally, a third cupola is running daily for soft grey iron, while a fourth (for about 6 hr. per day) melts high-duty white and alloy iron. Castings are produced in this section up to 22 tons in tensile; it is contended that there is innate virtue in metal produced by duplexing white and grey irons at the cupola spout which is not found in metal melted by a single process, though it may possess the same empirical composition. Every day, throughout the nine-hour melting period, castings can be produced in this foundry with any predetermined depth of chill, from $\frac{1}{8}$ in. upwards, to meet any specification.

The cupolas, supplied by Roper's, are all hand charged. The charges are made up from well-laid-out storage bins at ground level into stillages; they are transported by electric elevating trucks and lifted by one of two 2-ton hoists to the charging floor. All the cupolas are fitted with spark arresters and there is a magnificently-equipped control panel.

### Core Shop

The core shop is well mechanised and staffed mainly by girls. Practically every mould made in the foundry has at least one core and sometimes many more, so that the requirements in numbers are high. The quality demand, too, is outstanding, since the chilling property is so sensitive a function of section thicknesses and chill, sand mould and core juxtaposition. Many of the cores are made on special pneumatically-operated core-squeezing machines. These are shown in Fig. 10, and a general view of the core shop in Fig. 11. The governing principle of the machines is the manner in which a form-shape or "tup" for the interior of a core is forced into a core box containing loosely-packed core sand so as to perform three functions—outer shape, inner shape and consolidation of the whole—in one rapidly-executed thrust and withdrawal motion. Quite complicated cores, such as those shown in the illustration, can be produced at the rate of 480 per hour per machine—60,000 ploughshare cores per week—and the process is equally applicable to moulds. Changes of "tup" are made to suit individual boxes. A local yellow sand containing a little natural bond is used with proprietary core oils for these cores. Additional equipment to serve the core shop includes a steel-band conveyor, a vertical-type "Acme" continuous oven, and a sand drier. In the interest of fume removal, the core oven is on the far side of a partition wall from the core shop.

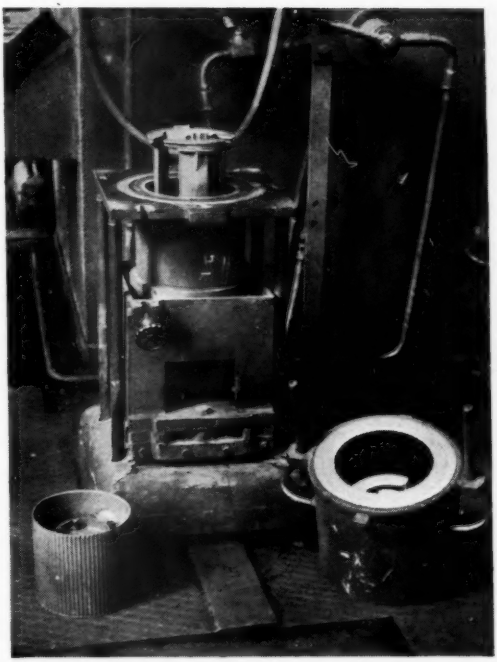

FIG. 6.—SPECIAL STRIPPER MACHINE FOR ROLLER CASTINGS. THE CORE-STRIPPING MECHANISM IS IN THE "RAISED" POSITION AND THE FLUTED SECTION, WHICH ALSO "STRIPS," IS HIDDEN.

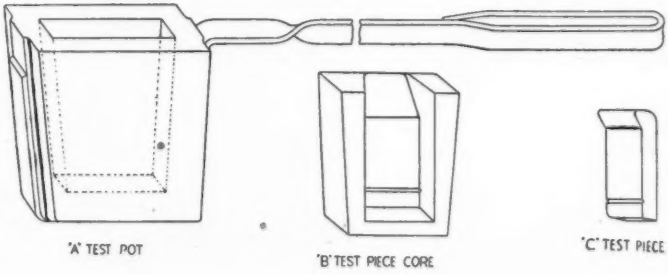


FIG. 7.—EQUIPMENT FOR MAKING THE "CHILL" TEST FOR PLOUGHSHARE METAL.

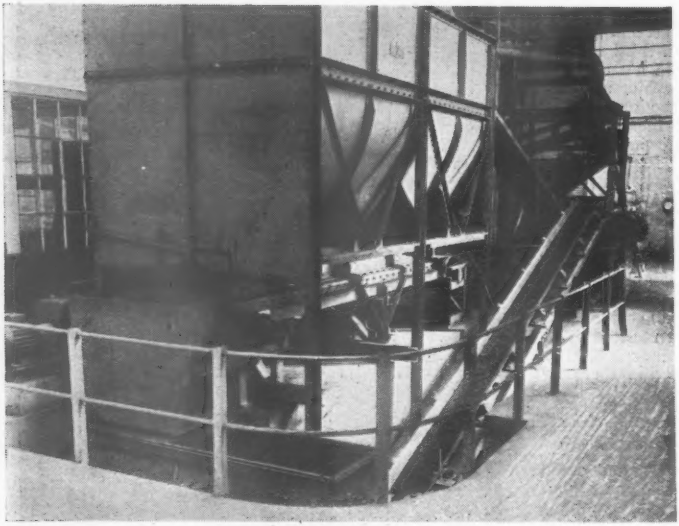

FIG. 8.—GENERAL VIEW OF THE SAND-CONDITIONING PLANT, WITH THE GRID-COVERED WORM-TYPE MIXER IN THE FOREGROUND.

### Auxiliary Departments

Spacious, airy and well-lit buildings walled off from the foundry proper, house the fettling shop, wood- and metal-pattern shops, a tool-room and a maintenance department. Metal patternmaking and chill construction is of necessity carried to a high degree of accuracy, and a large measure of craftsmanship is exhibited. Separately, there is a superb amenities block. In a

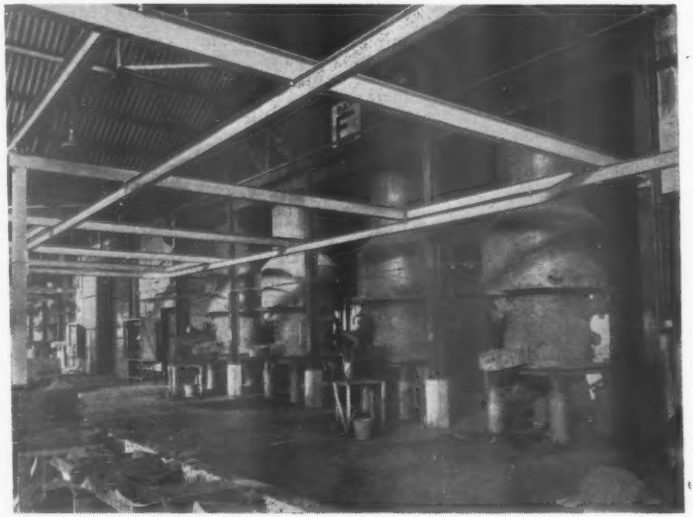

FIG. 9.—FOUR OF THE EIGHT CUPOLAS, WHICH ARE ARRANGED IN LINE IN TWO GROUPS. NOTE THE PROTECTIVE JACKETS FOR THE CUPOLA LEGS AND THE ROOF-SUPPORTING JOISTS.

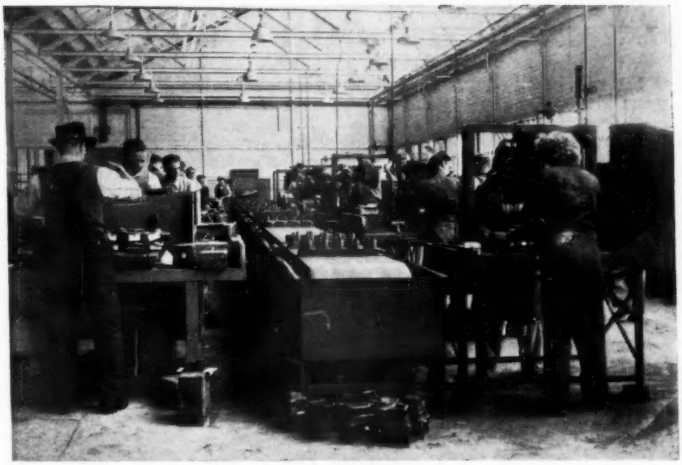

FIG. 10.—GENERAL VIEW OF THE CORE SHOP, WITH THE STEEL-BAND CONVEYOR IN THE CENTRE.

building covering approximately 10.000 sq. ft. there are canteens for men and girls, elaborate washing facilities and a resplendent health centre, the latter being staffed by a full-time nurse and a visiting doctor. In the same block as the canteen are the administrative offices.

### Flow of Materials

Apart from the obvious exceptions, most of which have already been described, the whole of the internal transport is a system of stillages moved by Ransomes' electric trucks. Batch sand, cores, finished castings, raw materials and a host of miscellaneous items are collected and moved about in this manner, for which ample concreted gangway space is available. Most of the castings are transported to the main works for machining; for this, too, stillages carried on a shuttle service of motor lorries are used.

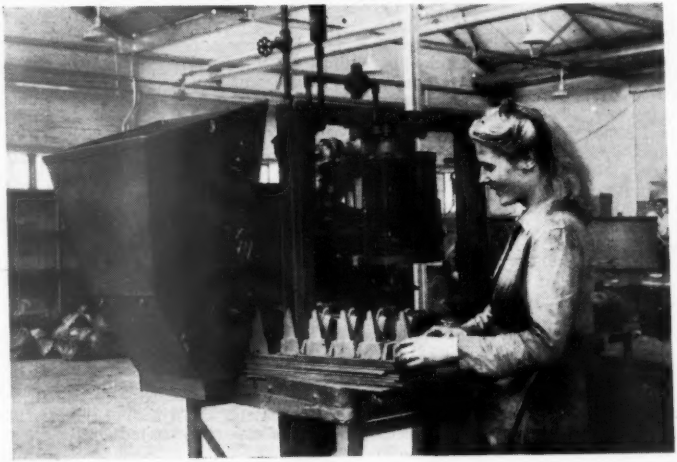

FIG. 11.—CLOSE-UP VIEW OF THE FORMING MACHINE FOR PLOUGHSHARE CORES.

## *Swords to Ploughshares*

### Starting-up

The starting-up of the new foundry was a dove-tailed operation of some magnitude, as may be easily envisaged from the preceding description. It involved the transfer over two week-ends of each section separately from the old works. The night shift on 'share production finished at 6.30 a.m. on Saturday morning, all their plant and tackle was moved over the week-end, and metal was "on-tap" at the new foundry at 7 a.m. Monday, 70 tons of 'shares being cast that week. Similarly, during another week-end, 140 lorry loads of equipment for the general-castings section was transported, and this section, too, started casting in the new home on Monday.

There is evidence in this enterprise of a virile individuality, particularly in the numerous home-designed or specially-adapted machines (such as the "stripper" moulding machine and the core-pressing machine. Without being dogmatic, the foundry designers have taken a modicum from latest practice, have added to a groundwork of proven methods a leaven of original development, and have welded the whole into a foundry suited admirably to its purpose. History records that the firm has made ploughshares since 1789, with relapses to "swords" during the two recent wars. With the new foundry, a milestone has been passed with—it is to be hoped—the augury of peaceful pursuits for a long time to come.

### Conclusion

The writer records his thanks to Ransomes Sims & Jefferies, Limited, for permission to publish this description of their new foundry. He is especially gratefull, also, to Mr. R. B. Reeve (publicity department) and Mr. A. J. Richman (foundry manager) for help in supplying details and photographs.

## Bridgnorth Looks Back to 1805

Memories of Bridgnorth's industrial days were recalled at a luncheon there on Thursday last, when Mr. John Pascoe, managing director of Fischer Bearings, Limited, Wolverhampton, presented to the town a scale model of the Trevithick-Pastreck engine, built there in 1805. At the same time, Mr. Howard Thompson, chairman of Thompson Bros. (Bilston), Limited, presented to the town a plaque to commemorate the fact that the world's first steam locomotive to draw a load of fare-paying passengers, was built there in 1808.

The plaque is to be erected near the site of the foundry at Low Town, Bridgnorth, of which John Pastreck was formerly a partner.

Presenting the model to the Mayor of Bridgnorth (Councillor M. A. Banks), Mr. Pascoe said the original was made in the Hazeldine Foundry in Low Town, and was the earliest of the true high-pressure steam engines. Presenting the plaque, Mr. Thompson said it had now been established that Pastreck was the production genius at the Bridgnorth foundry.

## British Standards Institution

### *New standard for aluminium and aluminium-alloy ingots and aluminium-alloy castings for general engineering purposes (B.S. 1490 : 1949)*

The various British Standards for aluminium and aluminium-alloy ingots and castings have now been combined into a single schedule, which has just been published as B.S. 1490:1949, aluminium and aluminium-alloy ingots and castings for general engineering purposes. The schedule also includes specifications for ingots and castings which have not previously been covered by standards. A system of nomenclature, in line with that adopted in the recently-issued B.S. 1470 for wrought aluminium and aluminium-alloys, sheet, strips, etc., has been adopted. The standard covers aluminium of 99 purity and 20 different alloys each in the form of ingots and castings. Details are also given in regard to the certification of compliance with the standard, independent tests, the provision of test samples and inspection procedure.

Particular attention is drawn to the fact that a few copies of this standard were distributed before October 3, 1949, containing a printer's error in alloy LM-6-M on page 22 where the percentage maximum limt for copper was given as 0.3 instead of 0.1 Would anyone possessing a copy with this error please return it to British Standards Institution and a correct copy will be supplied in return. Copies of the standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 7s. 6d., post free.

## 1951 Engineering Conference in London

The decision to hold a joint engineering conference in London from June 4-15, 1951, to coincide with the Festival of Britain has been announced by the Councils of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers. The theme of the conference will be to place on record the achievements of British engineers and will afford an opportunity for the engineers of the world to discuss the future trends of developing the great sources of power in nature for the use and convenience of man.

The conference will also underline the interdependence of all branches of engineering, for, as the official announcement states, none of the great developments in the last 100 years would have been possible without the constant and ever-growing co-operation of the members of the three major engineering institutions in Britain.

Mindful of the importance of maintaining the high standard and technical efficiency of British engineers in the future, the conference will also discuss the development of the system of education of engineers in Britain which, by the achievement of British engineers, has shown itself to be pre-eminently suited to the conditions in this country.

# Practical Experience with a Hot-blast Cupola Furnace Plant*

*By Otto Mattern*

All thermal processes, including that of cupola, must comply with the laws of thermodynamics; the heat brought into the cupola furnace must correspond to the amount of heat given up, whether useful or waste heat.

In some Papers on the functioning of cupolas, this fact has been somewhat neglected. Mainly, the waste heat represented by the CO content of the stack gases does not correspond to the other given values, *i.e.*, the quantity of heat introduced does not correspond to the heat evolved. This is due to the great difficulty encountered in the measurement of average CO values of the gases in the stack, because they are not uniform throughout the cross section and also change with time as they are influenced by the operation of the furnace.

If the heat inputs and heat losses are thoroughly investigated for an individual cupola, it is possible to determine from the results obtained the CO content of the stack gases. It is obvious, and it will be shown in an example later, that this method does not take into consideration the mechanism of the CO formation in the melting zone of the furnace, but the method enables one to obtain a clearer indication of the average composition of the stack gases than would be obtained by measurement. The minimum quantity of coke, which is theoretically sufficient for melting, can be calculated if the losses are determined, *i.e.*, the necessary heat will be the sum of the following: the heat to melt the iron, radiation losses, direct losses of heat absorbed in the plant, heat losses in the slag and the heat content of the stack gases at a temperature of at least 300 deg. C.

On this basis, the operation of a hot-blast cupola furnace, capacity 5 tons per hour, was investigated in detail. The coke required for increasing the carbon content of the iron was not taken into consideration. The temperature of the stack gases from the cupola investigated varied between 320 and 480 deg. C. Characteristic values are given in Table I.

Table II gives a picture of the conditions for various coke quantities in the charge, the conditions being investigated for 7, 9 and 11 per cent. of charge coke. The investigation applies to a desired blast temperature of 400 deg. C. and a normal cupola coke. All figures in the table are given per 100 kg. iron charges (about 220 lb.).

Instead of discussing the individual figures of Table II, it is preferable to analyse the curves of Fig. 1, which have been plotted on the basis of the values given in the table. It should be noted that both the table and the graphs represent only average theoretical values. Some of these values have already been confirmed by practical experiments, although the values obtained in the experiments showed some scattering. Some values also require further checking by practical measurements. It should, however, be pointed out that all these figures have been compiled with great care and they can unhesitatingly be used as average values. The curves of the CO and $CO_2$ contents are drawn to represent the field covered.

The fluctuating conditions of operation should be taken into consideration when considering the conclusions drawn from the investigations. It follows from the CO curve that, in the case of a charge containing 5.7 per cent. charge-coke, the stack gases should have a CO content of 3 per cent. and a temperature of 300 deg. C. According to the results of the theoretical investigations the melting system is completed when these values are reached. Owing to fluctuations of the CO content and other interdependent values, the bottom

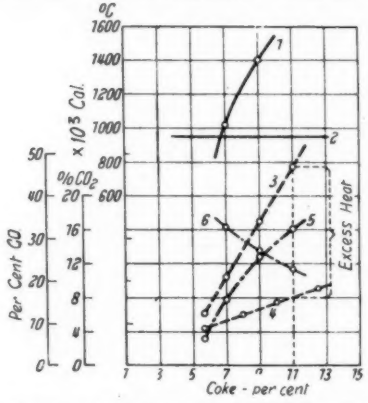


FIG. 1.—GRAPH ILLUSTRATING OPERATION OF HOT-BLAST CUPOLA FURNACE.

1.—Temperature of the gases after combustion of the CO with air at 400 deg. C. 2.—Temperature of the gas before entering the air heater. 3.—Sensible and potential heat of the cupola gases. 4.—Heat required for increasing the blast temperature to 400 deg. C. 5.—CO content of the cupola gases. 6.—$CO^2$ content of the cupola gases.

* An abridged translation from "Die Neue Giesserei," Vol. 36, 1949, No. 9.

## *Hot-blast Cupola*

limit at which satisfactory melting takes place is above the theoretical and with a charge-coke as low as 6.5 to 7 per cent. perfect melting would no longer be possible if the blast temperature were 400 deg. C. As it is highly desirable to superheat the melt owing to metallurgical considerations, the lower limit of the coke percentage in the charge has to be still higher.

These theoretical conclusions were checked experimentally. At the end of a working shift the coke content of the charge was reduced from 10 to 8 and later to 6 per cent. With 8 per cent. coke it was still possible to melt charges containing little steel scrap, but when the coke content was reduced to 6 per cent. unmelted pig could be seen in front of the tuyere a short time after part of the bed coke was burnt out. The liquid iron was hot up to the end, as the heat retained in the furnace lining must be regarded, in that case, as an additional source of heat. Investigation of the drop revealed that only one charge melted with 6 per cent. coke content while further charges came out almost unchanged.

The curves show also that only a fraction of the free and latent heat is utilised for blast preheating, while the major part of this heat must still escape up the stack. It can also be seen from the curves that the gas temperature after combustion of the CO is a direct function of the CO content. In the design selected, the temperature of the stack gases in front of the recuperator was limited to 900 to 1,000 deg. C. for safety reasons. Any higher temperature would have to be reduced by using a cooling system. The probable CO and $CO_2$ contents for the individual coke percentages are also clear from the curves, and it can be seen how sensitive the CO content is to excess coke content of the charge. It also follows from the curves that a cupola which is to work with a blast of 400 deg. C. cannot operate with less than 8 per cent. coke, as otherwise the available heat would not be sufficient for heating up the blast to the desired temperature. The figures set out in the table and the graphs are based on practical experience, and they can be summarised as showing the limits of fluctuation of the CO contents for individual coke-charge percentages. It should be mentioned that the exothermic reactions of the elements associated with the iron have been considered as being equal to the heat required for calcining the limestone; this was done for reasons of simplification.

Savings of 30 to 40 per cent. of coke can be obtained by using hot blast, and in fact such savings are obtained. However, it is necessary to bear in mind that the cupolas dealt with were operating with unusually-large coke percentages prior to their conversion to hot-blast operation, and this conversion eliminated the existing inefficiencies. It was found that hot-blast cupolas can work with decreased height because the temperatures of the stack gases are lower. The increased output per sq. ft. of the furnace area

TABLE I.—*Results of a Thermal Investigation of a Hot-blast Cupola Furnace.*

| 1. | 2. | 3. | 4. |
|---|---|---|---|
| Coke (Satzkoks), per cent. | Combustion heat, Cal. | Radiation losses, Cal. | Heat content of the molten iron, Cal. |
| 7 | 49,000 | 2,800 | 30,600 |
| 9 | 63,000 | 3,000 | 31,400 |
| 11 | 77,000 | 3,200 | 32,000 |
| 5. | 6. | 7. | 8. |
| Thermal efficiency, per cent. | Mean temp. of the stock gases, deg. C. | Volume of gases, cub. m. per kg. | Sensible heat of the cupola gases, Cal. |
| 62 | 420 | 7.2 | 8,300 |
| 50 | 450 | 6.9 | 10,500 |
| 41.5 | 480 | 6·6 | 12,900 |
| 9. | 10. | 11. | 12. |
| Combustion air required, cub. m. per kg. | Total air, cub. m. per kg. | Heat content of hot blast, Cal. | 2 + 11 − (3 + 4 + 8), Cal. |
| 6.8 | 47.6 | 6,070 | 13,370 |
| 6.5 | 58.5 | 7,500 | 25,600 |
| 6.2 | 68.2 | 8,700 | 37,600 |
| 13. | 14. | 15. | 16. |
| Sensible heat of the cupola gases, 12—Residual losses, Cal. | Sensible heat, Cal. per cub. m. | Mean values of the CO contents, Per cent. | Temperature of the stack gases after the combustion of CO, deg. C. |
| 11,900 | 236 | 7.7 | 1,020 |
| 23,700 | 382 | 12.7 | 1,400 |
| 35,300 | 485 | 16.1 | 1,620 |

*Note:* All values are given per 100 kg. iron. Coke used: 7,000 Cal/kg. Hot-blast temp., 400 deg. C. The carbon for increasing the carbon content of the iron is not included in the figures.

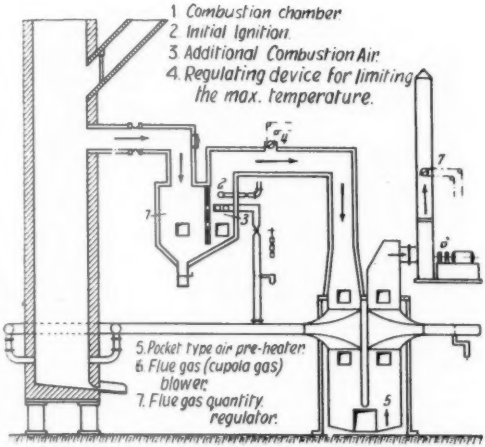
1. Combustion chamber.
2. Initial Ignition.
3. Additional Combustion Air.
4. Regulating device for limiting the max. temperature.
5. Pocket type air pre-heater.
6. Flue gas (cupola gas) blower.
7. Flue gas quantity regulator.

FIG. 2.—SCHEMATIC PLAN OF HOT-BLAST CUPOLA FURNACE.

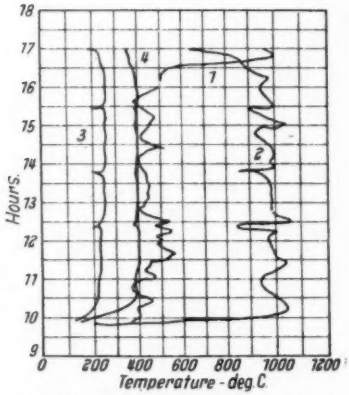


FIG. 3.—TEMPERATURE CURVES FOR THE HOT-BLAST CUPOLA.

1.—Temperature of the drawn-off cupola gases. 2.—Temperature of the stack gases before entering the recuperator. 3.—Temperature of the stack gases behind the recuperator. 4.—Temperature of the hot blast.

and the necessary change of the shaft diameter has also an influence on the design of the furnace. There are a number of other factors, *e.g.*, decreased depth of the bed coke, which have to be taken into consideration when changing over to hot-blast operation; almost all of these have a beneficial effect.

Reliability of operation was a primary consideration in the design of the hot-blast cupola described, and in this respect the operation of the furnace must be simple and easily controlled by the operator. A separately-heated air heater could not be considered, because it could not be allowed to waste valuable stack gases from the cupola which contain a considerable amount of both combustible gases and sensible heat, as can be seen from the graphs. The stack gases for blast preheating are drawn by a fan of the same type as is used in boiler installations, which has proved fully satisfactory.

An outline drawing of the hot-blast cupola installed in the firm of Steinmüller is shown in Fig. 2. The stack gases are drawn below the opening where the charge is fed in, through a chute into the furnace. This also acts as a dust-collector. Air, preferably from the hot-blast belt, is introduced, and the amount of the air added is related to the CO content of the gases. A small gas burner is provided to obtain uniform ignition of the CO-containing gases, and this burner can be turned out after a short time, when the

TABLE II.—*Conditions of Cupola Operation for Various Coke Qualities.*

| Coke, per cent. | Combustion heat, Cal. | Radiation losses, Cal. | Heat content of the molten iron, Cal. | Thermal efficiency per cent. | Mean temperature of the cupola gases, deg. C. | Volume of stack gases, cub. m. per kg. | Sensible heat of the cupola gases, Cal. | Air consumption, cub. m. per kg. | Total air consumption, cub. m. | Heat content of the hot blast, Cal. | 2 + 11 − (3 + 4 + 8), Cal. | Potential heat of the furnace gases (12-balance), Cal. | Latent heat, Cal. per cub. m. | Mean contents of CO, per cent. | Temperature of the stack gases after combustion of the CO content. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. |
| 7 | 49,000 | 2,800 | 30,600 | 62 | 420 | 7.2 | 8,300 | 6.8 | 47.6 | 6,070 | 13,370 | 11,900 | 236 | 7.7 | 1,020 |
| 9 | 63,000 | 3,000 | 31,400 | 50 | 450 | 6.9 | 10,500 | 6.5 | 58.5 | 7,500 | 25,600 | 23,700 | 382 | 12.7 | 1,400 |
| 11 | 77,000 | 3,200 | 32,000 | 41.5 | 480 | 6.6 | 12,900 | 6.2 | 68.2 | 8,700 | 37,600 | 35,300 | 485 | 16.1 | 1,620 |

*Note:* All values are given for 100 kg. weight of iron. Hot-blast temp., 400 deg. C. Carbon for increasing the carbon content of the iron was not considered. Coke at 7,000 Cal. per kg.

## *Hot-blast Cupola*

temperature in the combustion chamber becomes sufficiently high. The stack gases which leave the combustion chamber can attain temperatures of over 1,200 deg. C., depending on their CO content. The temperature can be controlled by a simple device and the recuperator is thereby protected from damage due to overheating. This control of the stack gas temperature is very important, because measurements over long periods have shown that the CO content is subject to fluctuations within very wide limits, as has been mentioned earlier in conjunction with the graphical representation in Fig. 1. A sudden increase of the CO content may lead to an undesirable accumulation of heat. The stack gases pass through the air heater and leave the suction system from the stack gas fan at a temperature of 200 to 250 deg. C. The incoming air for the cupola passes through the recuperator according to the counter or flow principle (in opposite direction to the flow of the hot gases) and is then led by insulated pipelines to the tuyeres.

It is well known that CO is a gas which reacts slowly and this is particularly noticeable here because the CO is diluted with stack gases. It is therefore advisable to initiate the combustion of the CO-containing flue gases. The ignition burner can be switched off as soon as the combustion-chamber temperature becomes sufficiently high. The installation represented in the schematic drawing (Fig. 2) has been in operation several months and has proved satisfactory. It was confirmed that the advantages claimed for such installations are obtained, *i.e.*, lower coke consumption, smaller combustion losses, hotter and more uniform iron, low sulphur content, even if low-quality coke were used. Thus, the innovation is definitely successful both from the point of view of heat economy and also from the metallurgical point of view. Thorough investigations of the gases leaving the cupola were carried out during the designing of this installation. The design of the recuperator was influenced by the fact that the gases contain much dust, and ribbed elements or elements of any other shape which would tend to collect ash deposits were excluded.

### Design of the Recuperator

The recuperator was provided with smooth air-preheating pockets similar to those used successfully in boiler installations where the flue gases have a high ash content. In the part of the recuperator where the heat stresses are highest, the components are made from chrome-alloy scale-resisting steel castings. The adjoining components are subject to lower heat stresses and are made from heat-resistant high-silicon cast iron, and those subject to still lower heat stresses are made from heat-resistant grey cast iron. Despite the use of smooth air-preheating elements, dust deposition initially caused difficulties. A particularly noxious property of the deposited ash was its low fusion temperature; sintering starts at 900 deg. C. This is an additional reason why it is so important to control the temperature of the hot gases before they are fed into the recuperator if sintering of dust on the preheater elements is to be prevented. Sintered dust particles cannot be removed by normal methods of cleaning, *e.g.*, blasting, and they have to be removed from the surface of the heating elements by chipping.

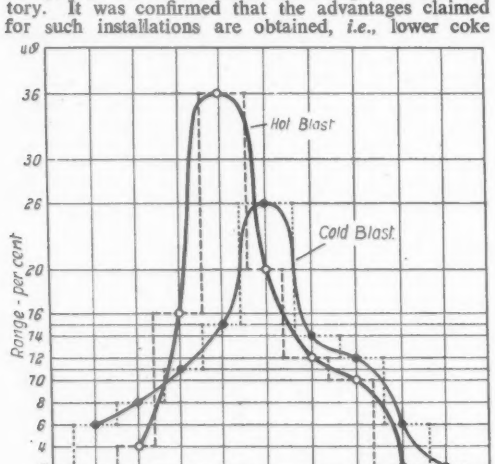


FIG. 4.—COMPARISON OF THE SILICON CONTENTS FOR HOT- AND COLD-BLAST CUPOLAS.

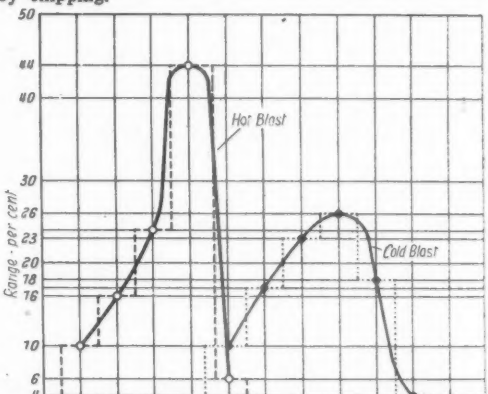


FIG. 5.—COMPARISON OF THE SULPHUR CONTENTS FOR HOT- AND COLD-BLAST CUPOLAS.

The furnace-shaft diameter had to be reduced to 800 mm. (32 in.) after changing over to hot-blast operation, because the yield of fluid iron had not to exceed 6 tons per hr., as this was the limit of the mould capacity. The output of the furnace is about 5½ tons per hr. and the air consumption is about 2,500 cub. ft. of air at 400 deg. C. per min. The wear of the lining was not greater than for cold-blast operation, although the temperatures in the melting zone were obviously higher.

The temperature characteristic of a melting cycle of about 6 hrs. is shown in Fig. 3. Detailed observation has shown that it is not advisable to preheat the recuperator with town gas, even if it has cooled down entirely. The combustion products of town gas contain much water vapour, causing unavoidable condensation in the recuperator. This precipitation brings about an agglomeration of the dust deposits in the recuperator, thus considerably accelerating the adherence of the dust to the recuperator elements. The blast temperature of 400 deg. C. is obtained after a maximum of 45 min. and, if the recuperator is in service every day, it takes only about 30 min. to reach that temperature. In Fig. 3 the curve (1) shows the temperature of the gases leaving the cupola furnace; curve (2) shows their temperature after cooling them down by a cooling medium and before they are fed into the recuperator. The temperature of the stack gases on leaving the suction system is shown on curve (3), while curve (4) shows the temperature characteristic of the hot blast. The slight interruptions in the continuity of the curves, particularly noticeable in the curve for the stack gases escaping into the air, represent individual tappings of slag. The temperature of the gases drawn off the furnace fluctuates between 320 and 480 deg. C. The steep rise of curve (1) at the end of the process occurs while the blast to the furnace is being reduced, because at that time partial combustion of the CO in the furnace shaft cannot be prevented. The slight temperature drop shown in the last portion of the hot-blast curve is due to special measures which are required to carry out the melting of a heat-resistant alloy containing about 2 per cent. C and 6 per cent. Si. With about 2,500 cub. ft. of air per min., the output was about 5,400 kg. (5.3 tons) per hr. Practical experience has shown that it is possible to operate the hot-blast cupola furnace with a considerably reduced blast without much adverse effect on the temperature and quality of the molten iron, if such action is necessary as a result of inability to use the total output of the furnace for any reason (*e.g.*, if the required quantity of castings is insufficient.

### Effect on Composition

Fig. 4 shows the range of Si contents in a cupola furnace with hot- and cold-blast operation. Charges are compared which have been currently prepared and utilised for a special purpose. The peak of the hot-blast curve is somewhat displaced relative to the peak of the cold-blast curve, and this is due to the fact that the iron melted with a cold blast is harder. The experimental melts are included in the values plotted for hot-blast operation, which explains the somewhat greater height of the hot-blast curve towards higher Si contents. The curve shows also clearly that greater uniformity is obtained by using hot blast. Fig. 5 shows the frequencies of the S contents. It should be noted that the S content of the coke used was considerably above one per cent. The S content of the hot-blast iron was generally below 0.1 per cent., while that of the iron obtained with the same coke in cold-blast operation was excessively high owing to its inferior quality. It should be borne in mind that in both cases (*i.e.*, for hot- and cold-blast operation) the values plotted in Fig. 9 were those obtained in normal operation. It was not possible to separate entirely the returned and other scrap in the various melts, and the scrap left over from cold-blast operation was used in the hot-blast operation, and this had an adverse effect on the results obtained. Further investigations of this kind are in preparation, but these cannot be published as yet because the available data are not adequate.

## Where the Money Goes

In an attractive, illustrated brochure the United Steel Companies, Limited, gives a detailed account of its activities during the year ended June 30 last, and information regarding the progress of the various development schemes at present in hand. While much of the statement on the past year's operations published on page 1040 of our issue dated October 28 is contained in the brochure, it does not by any means exhaust its contents which include considerably more details.

In addition to tables dealing with production and plant existing at the various associated works, one table gives an interesting analysis of shareholders showing that the number of people holding ordinary shares to the value of less than £500 total 13,727, representing roughly two-thirds of all the shareholders. Of 14,328 preference shareholders 6,098 hold less than £100 and 6,506 less than £500 worth. A further table indicating what the stockholders and employees take out of the business shows the following:—Employees' gross wages, £11,344,550; net wages, £10,643,022; average net annual wage, £380; gross salaries of staff, £1,172,933; net salaries, £965,498; average net annual salary, £687; stockholders' gross dividend, £1,045,000; net dividend, £575,000; average net annual dividend, £22.

Information of this nature clearly presented should be of great service in maintaining good relations in industry generally.

JOHN LEWIS & SONS, LIMITED, Aberdeen, has entered into a licence agreement with William Doxford & Sons, Limited. Sunderland, under which it will build Doxford opposed-piston oil engines. This step follows the completion by William Doxford & Sons, Limited, at Sunderland, of a three-cylinder engine developing 1,100 b.h.p. at 145 r.p.m. for installation in a 185-ft. trawler. This vessel, which is under construction by John Lewis & Sons, will be the first motor trawler to have a Doxford engine.

## Publications Received

**British West Africa.** By Aubrey R. Stark, O.B.E. Published for the Commercial Relations and Exports Department of the Board of Trade, by H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 1s. 3d. net.

The West African, in fact the whole of the African native market is particularly conservative, and once good business has been done, repeat orders can be relied upon. There is a cash value placed on many types of articles and these are used for barter. To be valid they must carry a certain trade mark. Thus, once this position has been achieved—and an effort is worth while—there is no need for salesmanship or modernisation of design. The reviewer has not received this information from the book under review, but from conversations with people familiar with the market. Thus one reads in this Report that British bicycles have achieved a virtual monopoly. If this is the case then all that is necessary is to go on supplying the type known and appreciated in the market. The reviewer wonders whether the creation of cheap "buy-and-take" stores in the larger towns and villages would not provide a better service than that now given by the empradore, his illustrated catalogues and his high charges for money lending. The report neither poses nor answers this question. Because of inflation, the use of sterling as a comparison between 1938 and 1948 values is now useless and should be discarded in Government publications. Only quantities are significant to-day.

**Fire Research Organisation.** Published by the Fire Offices' Committee, The Fire Protection Association, 84, Queen Street, London, E.C.4.

This is a reprint of an earlier publication brought up to date by the inclusion of additional matter and photographs. It is interesting to learn that wet water is being added to the ordinary variety as an aid to extinguishing fires. The pamphlet is very interesting as it describes the very modern research station at Elstree, where science is being harnessed to the work of extinguishing fires. It is available to our readers on request.

**Simplification in Industry.** A Productivity Report by the Anglo-American Council on Productivity. Published by the Council from 21, Tothill Street, London, S.W.1. Price 1s.

This Report, so far as the foundry industry is concerned, is rather puerile, as it merely reiterates in general terms that feature familiar to all under variations of the heading "Co-operation between Designer, Patternmaker and Moulder." It may, however, be of some interest to buyers of castings and, if it helps in reduction of types and sizes, then it will be welcomed.

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THE RT. HON. LORD CUNLIFFE has been appointed chairman of the National Gas & Oil Engine Company, Limited.

## New Catalogues

**Electrical Resistance Alloys.** From Samuel Fox & Company, Limited, Stocksbridge Works, near Sheffield, we have received a catalogue of outstanding merit. The cover is striking, making as it does full use of modern colour printing. The photographic reproductions are excellent and, where liquid metal is shown, it looks, as it no doubt is, dead killed. Too many photographers seem to like the "wild" variety. The catalogue also presents a wealth of data on wire sizes and the like for the three types of "Red Fox" alloys covered. The range is based on compositions designed for working temperatures from 900 to 1,300 deg. C. This eighty-page publication is available to our readers on writing to Mr. Douglas Wilson, the United Steel Companies, Limited, 17, Westbourne Road, Sheffield, 10.

**Electric Tools.** Readers are no doubt familiar with the reviewer's prejudice against folders as an advertising medium, but at last one has been received which is in every way excellent. It has just been issued by S. Wolf & Company, Limited, of Hangar Lane, London, W.5. It is obviously meant for the use of distributors, as the back page, when folded, is left blank for the insertion of the dealer's name and address. Many of the machines listed must be of real interest for garages and the like, but the grinders shown often form part of the equipment of the foundry fettling department. Because of this, readers should acquire and file a copy for reference purposes.

**Mechanical Handling.** Mechanised Handling Plant & Machinery, Limited, of 133/135, Euston Road, London, N.W.1, have just issued a catalogue taking the form of a loose-leaf binder. The cover is carried out in a bronze-blue border with an inset picture in Oxford blue of a pair of moulding machines being serviced by a pair of sand hoppers filled by a bucket elevator. The leaflets contained in the binder show this and other installations to have been standardised as units capable of being expanded. The plants dealt with are overhead hoppers, gates, bucket elevators, belt conveyors, push-plate conveyors and roller tracks.

**Infra-red Heating.** A very nice and extremely useful catalogue has just been issued by the General Electric Company, Limited, of Magnet House, Kingsway, London, W.C.2. The introductory section adequately explains in simple terms the fundamental principles of radiant heating. The next section details the plant available, while the third reviews some current applications, including that of mould drying. The catalogue is well illustrated and documented and maintains in all particulars the high standard so long established by the publicity department of the G.E.C.

**Tube-bending Machines.** A leaflet received from Chamberlain Industries, Limited, Staffa Works, Staffa Road, Leyton, London, E.10, describes and illustrates a two-stage hydraulic tube-bending machine. This hand-worked machine is capable of developing a bending force of 10 tons and weighs only 54 lb.

# Beryllium-copper Casting Alloys*

*By John T. Richards*

The place in industry of wrought beryllium-copper (strip, rod and wire) has been well established. Less, however, has been reported concerning cast beryllium-copper, although age-hardened castings deliver the same useful properties as obtained in wrought forms. This means that cast parts, depending upon the alloy selected, offer tensile strengths up to 76 tons per sq. in., or hardnesses up to 450 Brinell, or electrical conductivities to 50 per cent. that of pure copper.

In addition to high strength and good conductivity, the following characteristics of beryllium-copper may be of interest to materials engineers:—

(1) Non-magnetic; (2) good resistance to wear and corrosion; (3) superior elevated-temperature properties as compared with other copper-base alloys; (4) retention of ductility in sub-zero atmospheres, preventing loss of impact strength or low-temperature embrittlement; (5) good fluidity in the molten state, resulting in maximum detail in "as-cast" parts with minimum machining, and (6) relatively low pouring temperature, facilitating foundry handling.

There are now produced several beryllium-copper alloys—each presenting a different combination of desirable properties. Table I gives nominal compositions for three casting alloys.

The alloys containing 2.0 and 2.7 per cent. beryllium may be called "high-strength"; the 0.6 per cent. material, "high-conductivity." High-strength alloys generally find use where strength and hardness are of greater importance than electrical or thermal conductivity. The standard 2 per cent. alloy (No. 20) is the most universally employed casting material, while the others are of more limited application.

The physical properties of beryllium-copper casting alloys are listed in Table II.

## Selecting Casting Method

Beryllium-copper parts are regularly produced by sand, permanent-mould, pressure plaster and investment casting methods. The following discussion covers the advantages and limitations of each method:—

*Sand.*—Sand casting frequently offers the lowest cost for simple shapes requiring a minimum number of finishing operations and may provide the only feasible method of producing large parts. Sand castings are limited in size only by available melting and handling facilities.

Beryllium-copper sand castings find wide use in electrical and mechanical parts. The high-conductivity alloy (No. 10) is especially suited for current-carrying spring components in switches, circuit breakers, and switchgear. In the welding field—welding jaws, resistance-welding dies and electrode holders are frequently sand cast, particularly where size and shape requirements prevent economic use of wrought materials. High thermal conductivity, coupled with good resistance to wear and moderately elevated temperatures, suggests successful application in certain types of friction members.

High-strength sand castings (Nos. 20 and 275) serve as bushings, cams, pump parts, bearings, gears, flash-welding dies, valve parts, and similar applications. For marine propellers, the excellent corrosion resistance and high strength permits thinner sections with added resiliency. Beryllium-copper moulds for plastics are frequently sand cast where few cavities are required. Its high resistance to spark emission as compared to ferrous materials makes beryllium-copper suitable for safety tools in locations made hazardous by threat of fire or explosion. In addition to non-sparking tendencies, these tools are non-magnetic and resist corrosion.

Sand-casting practice for beryllium-copper is similar to that employed with other high-copper alloys. Electric, coke, oil or gas furnaces can be used; however, some care must be exercised to prevent excessive gas absorption. Fluxes or charcoal covers are generally not necessary for small heats. Although pouring temperatures vary with section thickness and casting size, high-strength alloys are usually poured in the range 1,065 to 1,120 deg. C., while the high-conductivity material is poured around 1,215 deg. C. Aluminium-bronze gating techniques apply.

## Gravity Die-casting

*Permanent Mould.*—Permanent-mould casting makes possible high rates of production over long runs, where the number of units is great enough to offset the initial

TABLE I.—*Nominal Composition of Beryllium-copper Casting Alloys.*

| — | Alloy. | | |
|---|---|---|---|
| | 20 | 275 | 10 |
| Beryllium .. .. | 2.00–2.25 | 2.60–2.85 | 0.55–0.70 |
| Cobalt .. .. | 0.35–0.60 | 0.35–0.65 | 2.25–2.60 |
| Copper .. .. | Balance | Balance | Balance |

TABLE II.—*Typical Physical Properties of Several Beryllium-copper Casting Alloys in Fully Heat-treated Condition.*

| | Alloy. | | |
|---|---|---|---|
| | 20 | 275 | 10 |
| Specific gravity .. .. | 8.09 | 8.09 | 8.61 |
| Density (lb. per cub. in.) .. | 0.292 | 0.292 | 0.311 |
| Magnetic properties .. .. | Non-magnetic | Non-magnetic | Non-magnetic |
| Melting range (° C.) .. .. | 863–954 | 863–954 | 996–1,066 |
| Modulus of elasticity × 10⁶lbs. | 19 | 19 | 18 |
| Average coefficient of linear exp.: (Per ° F.) .. .. | 0.0000095 | 0.0000093 | 0.0000098 |
| (Per ° C.) .. .. | 0.0000170 | 0.0000166 | 0.0000177 |
| Thermal conductivity: (B.T.U./ft.2-ft.-hr.-°F.) .. | 67–75 | 59–69 | 133–150 |
| (Cal./cm. 2-cm.-sec.-°C.) .. | 0.27–0.31 | 0.24–0.28 | 0.54–0.61 |
| Shrinkage (in. per ft.) .. | 1/8 | 1/8 | 1/8 |

* An abridged version of an article appearing in the September issue of "Materials & Methods."

## *Beryllium-copper Casting Alloys*

mould cost. In addition to production economies, permanent moulds ensure uniformity and minimise finishing operations through faithful reproduction of surface detail.

Moderate strength and hardness are obtainable in permanent-mould castings heat-treated from the "as-cast" condition, since the relatively high heat-transfer rate through the mould serves as a partial quench. For maximum properties, castings should be solution-annealed prior to age-hardening.

### Pressure Die-casting

The unique combination of properties available in beryllium-copper pressure die-castings suggests many applications. Parts, which are cast under pressure applied by a hydraulic press, have an unusually dense structure together with excellent surface finish, which retains the detail of the master hob. Finishing operations are limited to liquid honing. Through age-hardening, pressure castings obtain a high degree of strength and hardness coupled with good conductivity.

Beryllium-copper moulds have effected important cost-savings in the plastics industry and are extensively employed in the injection moulding of many industrial and novelty parts. Sand-cast moulds are used for large cavities or forces exceeding 50 lb. or where few castings are required. Pressure die-cast moulds, however, prove more economical in many applications through fewer finishing operations.

Advantages of pressure die-cast beryllium-copper moulds follow:—

(1) Low initial cost through the elimination of expensive machining necessary in steel cavities where hobbing is not practical; (2) since cavities are produced from master hobs, multiple cavities of exact likeness are readily produced at low cost; (3) sound castings, free from porosity, mean good properties as measured by high compressive strength and hardness; (4) a thermal conductivity 2¼ times that of steel gives substantially increased production rates; (5) cavities can be chromium plated when necessary to prevent corrosion by certain plastics; (6) raised sections, including lettering can be pressure cast with beryllium copper, whereas steel cavities require machined inserts, and (7) "as-cast" tolerances for pressure castings can be held to plus or minus 0.004 in. per in.

These same advantages are also of significance to the die caster, since they offer reduced tooling costs in the preparation of short-run dies.

The best results have been obtained through the use of the 2.7 per cent. beryllium-content alloy (No. 275) as a mould material. Molten beryllium-copper at 1,150 deg. C. is poured into a steel cavity, then pressure is applied before the metal freezes. Hydraulic presses of 20 to 200 tons capacity will supply required pressures ranging from 2,000 to 10,000 lb. per sq. in., depending upon size and shape of hob. After removal from the press, castings are solution annealed 1 to 3 hr. (depending upon section thickness) at 730 deg. C., followed by an immediate water oil quench. Cavities are then liquid honed prior to the hardening heat-treatment of 3 hr. at 315 deg. C.

### Plaster Moulds

Plaster-mould castings generally range from small to medium in size and are superior in surface finish to sand-cast parts. The good castability of beryllium-copper helps in attaining dimensional accuracy. Tolerances of the order of plus or minus 0.005 in. per in. can be held over small sections. Cast parts generally require little machining; however, where necessary for critical applications, some allowance should be made to permit a light finishing cut. Beryllium-copper parts cast by the plaster-mould process offer sharp detail, smooth surfaces, good dimensional control, and uniformity over long runs.

In plaster-mould work, polished metal patterns are required, since dimensional control is determined by pattern accuracy. The first step in the process is the introduction of fluid plaster around the patterns, which are removed from the mould when plaster solidifies. Moulds and cores are then baked to drive off moisture, so that little or no gas is evolved during pouring. Following cooling, moulds are broken up and castings are solution annealed. Where necessary, machining should follow annealing and precede the low-temperature-ageing treatment, which produces maximum properties.

### Investment

Investment or "lost-wax" casting provides a comparatively new method of casting small precision parts. This process frequently presents outstanding cost-saving and design opportunities.

To prevent misapplication, engineers should carefully consider the following points:—

*Advantages*

(1) Reduced costs through accurate reproduction of detail in "as-cast" parts without machining; (2) reduced cost through soft metal dies for short runs up to several thousand pieces, and (3) reduced costs through flexibility of design, permitting the combination of several sub-assemblies to give final parts not otherwise obtainable.

*Disadvantages*

(1) Relatively simple and symmetrical shapes can be produced faster and cheaper by automatic machining methods; (2) cannot compete on price with sand castings requiring few finishing operations, and (3) for large parts, sand castings provide equivalent accuracy at lower cost.

By virtue of its unexcelled casting characteristics, beryllium-copper is finding increased use in electrical, mechanical and novelty parts produced by the investment casting method. Long, thin cores, knife edges, relatively large flat areas, blind holes and narrow slots are typical of the sharp detail obtainable in "as-cast" parts. In addition, dimensional tolerances can be held to 0.002 in. per in., wall thicknesses range from 0.030 to 0.250 in., and holes as small as 0.020 in. can be produced in light sections. Relatively-low pouring temperatures permit the use of an easily and

(*Continued on page* 639)

*Institute of British Foundrymen* — *East Midlands Branch*

# "The Tools We Use"

## *Mr. C. A. Payne's Presidential Address*

In his address at the first meeting of the new session of the East Midlands Branch of the Institute of British Foundrymen, Mr. C. A. Payne began by quoting from the words of Mr. John Cameron, J.P., at the I.B.F. Glasgow Conference of 25 years ago:—

"We are still very conservative and reluctant to leave the beaten track. During the past few years, however, we have seen abroad foundrymen who have not been afraid to strike out on new and original lines in respect of cupola work, moulds and gating, testing and patternmaking, and more recently in obtaining cast iron in its strongest physical structure . . . not occasionally by chance, but regularly and uniformly. Let us trust that our Institute will be encouraged to leave "rule of thumb" and take its share in discovering and making known improved methods and procedure. In regard to the future of the industry there is a vast field for improvement in method, in organisation and in research."

How similar, Mr. Payne continued, are the trends of thought and activity in the foundry industry today. Then, as now, the research and ideas arising in this country had been brought to fruition overseas, and although the patient work and understanding of Morrogh and of the British Cast Iron Research Association provided the key to the latest developments in the metallurgy of cast iron, we find that it is not in this country that the biggest production-scale work has been carried out.

Tonight we are concerned with rule of thumb, with the improvement in method, in organisation, and in research. The Institute of British Foundrymen through its manifold activities has contributed greatly to the progress of the past 25 years, and, from your president's personal experience of the work of the technical council and its sub-committees, is still doing much to help and further the progress of the foundry industry.

Much progress can be made by a better understanding of "the tools we use." Taking this phrase in its widest sense, we can cover not only machines, instruments and equipment, but personnel, organisation, in fact all the units, large or small, mechanical or animate, employed in making castings. The potential value of the tool for the job lies not only in its form and nature, but also in the degree of consistency with which it operates, and to what extent the reproducibility of its results are governed by the need for recalibration, repair or replacement in terms of time and equivalent output. Its actual value lies in its use, and in the understanding with which it is used. To some gifted few this understanding is instinctive, to the majority of us it is the result of patient application and hard-earned experience.

### Essentials of Measurement

Understanding the tools we use involves not merely a knowledge of their purposes, or duties, but of the tolerances and inaccuracies to be associated with their products. Our technical objective should always be greater control, greater consistency and thus greater reliability. It behoves us to seek the sources of variation and though we might not at all times be able to suppress them, we should at least keep their existence in mind. When we use a graduated scale to measure a dimension, *e.g.*, a ruler for checking the length of a line, we standardise the conditions under which we use the scale, we select the fineness of graduation according to the limits of accuracy required and, if two operators, using the same rule, obtain differing results for the same dimension, then that is not the fault of the rule or the dimension. If the conditions are identical for both measurements, then the difference between the results is a measurement of the experimental error, or more bluntly, the inaccuracy involved, and the tolerances accorded to the reading must take this into account.

With operations or processes involving more variable units, the tolerances must perforce be widened. Take the example of the output of a simple hand-press moulding machine—operating on a specific job with standardised method and moulding tackle. We have here not only the human factor, but variables due to the mechanical condition of the equipment and to the variation in sand properties. Each of these three factors is in itself composed of varying properties, but by virtue of experience, and with more precision as the result of time and motion study, an average result can be predicted. The range of results is by no means so easily determined. The use of an arbitrary 10 per cent. allowance for eventualities is a tacit admission of this difficulty. By intelligent maintenance, the mechanical factors can be kept to a reasonable degree of consistency, but do we know the precise influence of deviations from the standard conditions of mechanical operation? Within the permissible ranges of sand properties, as dictated by casting finish and freedom from sand defects, can we say that we know the best combination of moisture content, of strength, of permeability, of "mouldability"; in effect, which will enable a mould to be rammed up in the shortest time without sacrificing the standards of casting quality? Do we know, in fact, what are our standards of quality, or are they just whatever we can persuade the customer into accepting?

## *Mr. C. A. Payne's Presidential Address*

### Summation of Variables

All know that much work has been, and is being, carried out in investigating the effects of grain shape and size, of size distribution, of bonding material, and of all the other factors contributing to the properties of moulding sand. Do we know what are the limits of reproducibility of our sand mill, can we say that not only milling time, but the influence of load, speed, adjustments to the component parts of the mill and order of adding the constituents are understood? The objection will be immediately raised that, as conditions vary so, such knowledge is not very practical, and immediately we must answer yet another question, do we even know what these varying conditions are, let alone their influence? A group of results taken from a number of consecutive millings of the same sand mix will reveal the limits of reproducibility of the milling operation. Do we even know this? In this case, we are dealing with a mechanical mixture subjected to mechanical treatment. If chemical reactions are introduced, the complexity of operation increases to such a point that " rule of thumb " is oft-times the last depairing refuge from troubles. The cupola involves a continuous cycle of physical and chemical reactions. We can standardise the procedure of operation, but we cannot observe the course of events between the raw materials entering the furnace and the molten metal and slag issuing at the end of the process. We know many of the principles involved, we know many of the factors affecting the result, in fact we know more than we understand. But this much at least we should comprehend, that variations in cupola performance are not the results of a malign personality in an otherwise inanimate structure, but simply the results of variations in materials and conditions.

This is a tempting subject, and one dear to the hearts of practically all ironfounders. Time and the field to be covered do not permit of further delving into this topic, but it is germane to underline two features not generally recognised. The concept of dynamic equilibrium rules out any possibility of altering one thing at a time, for as one factor is altered, all others involved automatically change to come into balance with that one. Oxidation and reduction are simultaneous occurrences in the cupola process, and a balance has to be maintained between them, should the one or the other become the predominating condition, then profound variations in metal properties will ensue.

When one comes to consider the processes and reactions involved in the organic items, the man on the job, the executive or supervisor, the adviser or technical servicer, then the complexity of the cupola process pales into insignificance. So great is the difficulty of analysis or measurement, that we have to invent a mythical being, " the average man," in order to get any workable basis at all. In repetitive production processes, much is done to reduce tolerances and inaccuracies by the stipulation of standard movements, equipment and conditions. As so many of these factors are directly under the control, or at the discretion of the operators, then one is very much in their hand, as to how far these standards are being observed. Standardisation of these variables is of utmost importance in maintaining quality and quantity within definite predictable and controllable limits, probably more so than are many of the craft secrets and private tricks of the trade imparted to the apprentice by the skilled moulder of bygone days. Much can, and should, be done to implant the idea of the importance of standardisation in the minds of foundry recruits during their educational and training stages, and this aspect of foundry technique merits considerably more development in technical curricula.

At this point it is not out of place to refer to the old foundry joke, " is a manager an asset or a liability? " and to think of all the words spent in argument of the relative merits of the skilled craftsman or the comparatively non-technical man as a manager. In support of what has been said so far, we should underline the fact that the most enduring success has attended the efforts of those men who understood best the tools they used. Many an, initially, " non-foundryman " has, by his ability to use his personnel within the limits imposed by their own " tolerances and inaccuracies," achieved this success.

### Indirect Producers

With the broad interpretation we are putting on this theme, one might dwell for a moment on the larger organic units, the internal divisions or subdivisions of a foundry organisation. These can be classified broadly as direct or indirect producers, and it is with these latter, the service units, that it is proposed to deal. As typical examples may be quoted estimating, production planning, time study, progress, fettling, inspection, laboratory, maintenance, personnel and welfare, all varying in size and status from firm to firm, but all present in one guise or another as tools for the job and tools to be used. As such, they all have their bearing on production quality or quantity, and are subject to the tolerances and inaccuracies applied to the foregoing examples. This viewpoint is not so simply demonstrated nor discussed, for it is not everyone who has to deal with many units as part of daily routine, and even of those who are in such a position, not all can or wish to see the whole pattern. To the executive in charge of any one such division or group of divisions, the demands, the interests, and the intricacies of all others may often seem subordinate to those of his own responsibilities, but without a true appreciation of this over-all pattern it is difficult to maintain a balanced progress.

### Interpretation of Statistics

Perhaps we may understand this problem a little more clearly by considering those departments or sections whose output is in terms of figures or data. The air of accuracy and finality conveyed by statements to the third place of decimals, or the aura of

infallibility surrounding the technical expert's pronouncement of opinion are by no means to be taken always with blind acceptance. Nor, equally, should every such item be automatically received with cynicism or suspicion.

A simple example of the limits to be placed on the interpretation of reported figures can be given in connection with the tensile test. This test involves making a sound sample of cast metal, machining to specified and measurable dimensions, subjecting it to a load which is capable of determination mechanically or by pressure gauge and, finally, a small calculation. All of these factors can be standardised and maintained within very clear margins. Cast ten such samples, each individually run and fed, to give the maximum freedom from defects, all under ideal conditions from the same ladle of metal, machine them and test them, and one finds, not ten identical results, but ten results lying within a range fairly evenly spread either side of the mean of the ten results. With good practice and conditions the range may be ten per cent. of the mean value, so that if we take a simple test result, we can say that with good luck, we have a result to within plus or minus five per cent.

The care bestowed upon the measurements involved may warrant the calculation being carried to the third significant place, but as a measurement of the strength of the metal or alloy, then this fine-limit calculation rather loses its significance. It should not be taken that care in carrying out the test is not imperative, but understanding of the tolerances and inaccuracies must be used when studying the results of the test. Time spent in determining these operational ranges in the measurement of constituents or properties is time valuably spent if we wish to advance beyond mere estimation in our analyses and testing. If we can discover some of the sources of error and reduce these ranges then we have made definite progress towards our objective of greater consistency.

In the foundry each day there are to be seen many more than the few isolated examples lightly touched on above. Through continued familiarity we can easily over-rate our understanding of the tools we use. Stealing again the thunder of past presidents by another quotation from that address of 25 years ago, the position may be summed up by saying:—

"One has to take some trouble, but help is to be found in the interchanges of experience, and visits to works which membership (of the Institute) implies, and the reward is the realisation of at least part of an ideal, a keener interest in our own work, and increased satisfaction and confidence from our customers."

Do not let us forget that the Institute of British Foundrymen is another of the tools which we can use, if we will. Whether merely as a stimulus to thought or action, on our part, or as a means of obtaining information, help or investigation in connection with our own problems on a nation-wide basis, it is up to us to make the first move if we wish to get the true value of membership.

### *Beryllium-copper Casting Alloys*

(*Continued from page* 636)

economically-handled investment, which is in contrast to ferrous and nickel-base alloys having high melting ranges.

In comparison with steel, beryllium-copper offers superior corrosion resistance and conductivity, and compares favourably in strength, hardness and wear resistance. Moreover, beryllium-copper gives better detail, smoother surfaces and closer dimensional control. Compared with other copper-base alloys, beryllium-copper parts are stronger and give better resistance to wear and moderately elevated temperatures.

Steel or soft-metal dies, depending upon the number of parts and intricacy of detail required, are used to form wax or other low-melting patterns. After the surrounding investment fills the mould and hardens, heat is used to remove patterns. The metal is then poured either by gravity or centrifugal methods. The 2.0 per cent. beryllium material (Alloy No. 20) has been found to offer the best combination of properties for investment casting.

## Birmingham University Appointments

Dr. Geoffrey Vincent Raynor, Reader in Theoretical Metallurgy at Birmingham University, has been appointed its first Professor of Metal Physics. Dr. A. H. Cottrell, who is engaged on metallurgical research work at the University, has been appointed Professor of Physical Metallurgy. These appointments raise the number of chairs in metallurgy to four.

Other appointments announced by the University include Dr. G. F. J. Garlick as lecturer in physics; Dr. J. H. Turnbull, lecturer in chemistry; Dr. Elsie A. G. Knowles, lecturer in industrial statistics in the Department of Engineering Production; Mr. H. Grisbrook, lecturer in tool engineering and metrology in the Department of Engineering Production; Mr. D. J. Desmond and Mr. L. A. Ferney, Tube Investments Research Fellows in the Department of Engineering Production; and Mr. J. F. Hayes, senior research assistant in the Faculty of Commerce and Social Science.

## I.B.F. Elects Honorary Member

At a meeting of the Council of the Institute of British Foundrymen, held in London on October 15, Mr. J. Cameron, Snr., J.P., past-president, was elected an Honorary Life Member as a recognition of his services to the Institute and to the industry.

In proposing the resolution, Mr. D. H. Wood, past-president, said that Mr. Cameron was a pioneer in many phases of foundry practice, especially in high-duty cast iron. He was every ready to experiment and equally willing to help any member with his knowledge. He was the son of a foundryman, a skilled foundryman himself, and the father of three sons, all foundrymen.

He was one of the best-known foundrymen in the country and, in fact, wherever foundries exist in any part of the world, but above all he was a staunch friend and a charming and most lovable man.

# Correspondence

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

## CUPOLA CHARGE MATERIALS

*To the Editor of the* FOUNDRY TRADE JOURNAL

SIR,—Readers of your JOURNAL who heard the discussion of the Report of Sub-committee T.S.27 at Cheltenham must have shared my surprise on reading your account of Mr. H. J. Young's contribution. Your report reads: "Mr. H. J. Young, opening the discussion, said. . . ."

On July 27 I received your representative's report of this discussion and, as requested, "incorporated any necessary amendments." I left completely unchanged the stenographer's record of Mr. Young's contribution, which was reported as follows:—

"Mr. H. J. Young said he thought the report ought to be called 'The Gipsy's Warning.' It seemed to him to be a mass of warnings. He had two cupolas. He had used 80 per cent. of scrap in the last few years, he had not followed any of the directions given in the report and he had not had any trouble. He had used iron and steel scrap with heavy coatings of rust—he was using it at the moment—without any trouble, and he had done none of the things recommended in the report. He had been using heavy steel charges before mechanisation came to this country, but again he had not done anything recommended in the report and he had never desulphurised. He had worked cupolas as far away as Shanghai, in India, in Mr. Braidwood's country and in England as a consultant, and honestly he had not done what was being recommended in the report. He might be utterly wrong."

Such were Mr. Young's remarks, as reported substantially verbatim from the discussion. I made what I considered to be a reply suitable to such a generalised, unsubstantiated criticism.

While it is not disputed that opportunity should always be given to participants to "tidy up" their contributions, comparison of your published version with Mr. Young's actual remarks shows that Mr. Young has gone on record as saying much that was not, in fact, said at the meeting. Publication of this expanded account, followed by my actual, terse rejoinder, gives a regretably wrong impression. Since I was given no opportunity to see these afterthoughts of Mr. Young until they appeared in print, will you allow me here to answer them as I would have done had they been provided as a written addition to his actual contribution?

In discussing the use of high proportions of cast-iron scrap in cupola charges, the report first explains that the primary need is to maintain silicon and manganese at normal levels and then recommends the employment of higher-silicon and higher-manganese pig, or the addition of ferro-silicon and ferro-manganese. Mr. Young states emphatically that he ". . . had taken none of the measures recommended in the report." We must presume, therefore, that he simply increased the proportion of scrap and decreased the proportion of the normal pig-iron and made no other changes. The Committee would deprecate such procedure.

The Committee's statement that founding difficulties were liable to be experienced, in the form of sinks, draws and hard sections, when charges of unorthodox type were used, is drawn from the experience of Committee members. The recommendation, it should be pointed out, was not that gating and feeding methods should necessarily be altered, but that they should be given careful attention. In other words, a watch should be kept for those less-efficient methods which, although giving reasonable results with an accommodating type of iron, would be less successful when shrinkage became somewhat more pronounced.

Mr. Young's statement that ". . . he had been landed with many tons of the filthiest scrap iron he had ever seen, thin, small, very rusty and scaly," is of particular interest. From the choice of words, the reader must infer that Mr. Young, like the Committee, prefers to avoid the use of such material in cupola charges. He indicates, moreover, that when he has to make use of such material, he is not above adding extra limestone—as the Committee recommends.

The Committee had very much in mind encouragement to greater use of steel scrap, with attendant saving in scarcer materials, by those foundrymen who earlier had melted only small proportions of steel, or none at all. The guidance given is based on the well-founded experience of Committee members, and inoculation, to avoid the occurence of hard sections, is just one of those measures which may make all the difference between satisfactory adoption and hasty abandonment of the modified technique. On the subject of de-sulphurisation, Mr. Young has probably overlooked the problems which confront operators of cupola-fed converters, who are, of course, among those whom this report is designed to serve. Only in the instance quoted and in discussing the production of synthetic pig-iron does the Committee lay stress on de-sulphurisation. In all other cases the guidance is that de-sulphurisation, where practicable, is desirable.

The section headed "Machine-cast or Sand-cast Pigs" has as its main object the encouragement of foundries, which have previously used only sand-cast pig and have relied greatly on fracture appearance, to make use of machine-cast pig where necessary. The recommendation is that, regardless of fracture, they should simply check that the machine-cast pig has the composition of the sand-cast pig normally used with good results. In other words—indeed, in Mr. Young's own phrase—"Analysis was wanted only of what went into the cupola, and the pig-iron makers supplied it free of charge." The Committee decided not to include an explanation of how carbon equivalent should be calculated. There were two reasons for this decision. The first was consideration of length. The second was the fact that an excellent Paper on the subject was due to be presented just before the Cheltenham Conference, as the I.B.F. Exchange Paper to the American Foundrymen's Society (Angus, Dunn and Marles, "The Mechanical Properties and Structure of Cast Iron in Relation to Composition and Carbon Equivalent Value").

It is admittedly difficult to please all tastes. Mr. Young, who earlier makes rather scathing reference to

the length of the report, also considers that in studying the subject the Committee should have cast its net further back over the years. Another questioner, however, had calculated that sixty-nine references were quoted and thought that figure too great. It would probably be useful to re-emphasise here that the Report is intended to be of help to all foundries, enabling foundrymen everywhere to draw from it the guidance which best suits their particular circumstances.

The Committee fully realised that it was tackling the most controversial subject in the foundryman's world, and lively discussion, even to the extent of caustic criticism, was fully expected. It is only fair, however, to record that, due to over-running of the previous Paper, a period of rather less than fifteen minutes was available for discussion of this report at Cheltenham. As a result, it was impossible to obtain a truly representative expression of opinion on the report and undue prominence has been given to two contributions of a solely destructive character. Mr. V. C. Faulkner's comment at the end of the published account of the discussion is appreciated, and it can also be stated that approval of the Report has been expressed directly to members of the Committee from many sources. The Report is scheduled for presentation in Middlesbrough on December 9 and in Cardiff on February 25, and the Committee looks forward to the opportunity which these occasions will provide for calm, unhurried, and more helpful discussion.—Yours, etc.,

W. W. BRAIDWOOD.

Tolworth, Surrey. November 15, 1949.

## KIBBLES

*To the Editor of the* FOUNDRY TRADE JOURNAL

SIR,—I have read with interest the recent notes in your JOURNAL regarding the meaning of the word "Kibble." I feel that perhaps I am entitled to speak with some authority on the subject, and so I submit the following information.

The "English Dialect Dictionary" and other works of reference yield some twelve different meanings, including "a cudgel," "a hunting dog," "dead-leaves," etc. The two chief uses, however, appear to be "a wooden or iron bucket used in mining" (as mentioned by Mr. Harris), and to "grind or crush." The latter use usually refers to processing corn or fodder, particularly in the Midland districts, but it is also used for chipping stones, and for crushing coal. From this use it is easy to see how the word came to be used meaning degree of crushing, as stated in your issue of November 3.

There seems little doubt that former members of the family were mining engineers, who gave their name to these processes. The name itself probably derives from the old Scottish adjective, "kibble," meaning strong and active, or, a less flattering thought, the English one meaning cramped or small. —Yours, etc.,

JOHN D. KIBBLE,
B.A.(Cantab.), G.I.Mech.E.,
Development Engineer, Glacier Metal Company, Limited.

4, Champneys Close,
Cheam, Surrey.
November 15, 1949.

# *Book Reviews*

**Institute of Australian Foundrymen (Victorian Division) Annual Proceedings for the Years 1944-1947.** Vol. IV. Price on application to the Institute, Melbourne Technical College.

The President of the Institute for 1946 and 1947 bears the very appropriate name of Mr. R. A. Cheers, for under his leadership he brought much "cheer" to the homes of members of the Institute of British Foundrymen through the despatch of food parcels. The reviewer, being a grateful recipient, takes this opportunity of thanking his fellow members resident down under. The Proceedings shows that the Institute continues to grow in membership—it has now 165 members in Victoria—and in technical standing. There are no fewer than 22 Papers and discussions contained in its 350 odd pages.

The technical worth of these Papers is such that it is suggested that the date of presentation should be included so that priority of statement can be accorded, for the period of three or four years is too extended for this purpose. The contents are predominantly cast iron and general foundry practice, there being very little non-ferrous matter. There is a Paper on the training of apprentices by Mr. A. Stephenson. He, like so many others, regrets the inability of the Australian foundry owner to attract apprentices, but also he, like most others, has not regarded the problem as just another selling job. The customer in this case is a youth who takes himself as seriously as a bishop, but is still a kid. He has to be written to or approached by someone capable of understanding the mentality of youth. The use of badges and trade certificates helps, but the main factor is the psychological angle. Its practical application has been a proved success.

The reviewer also found interest in a particularly well written, idealistic, but rather disjointed Paper by Mr. W. O. Adams. However, it created a good discussion on manganese bronze though the author devoted but a paragraph to this subject. Mr. W. T. Main, a founder of the Institute, has with his staff and colleagues been responsible for several high-grade Papers. By and large, there is a wealth of practical and technical information in the book, and foundry technical literature has been much enriched by its publication. V. C. F.

**Selling in a Buyers' Market.** By H. Stuart Jude. Published by Danetre Publications, 92, Reservoir Street, Rugby. Price 10s. post free.

The reviewer found this book quite tedious to read and most of the arguments trite. The relation of stories of a salesman who got the buyers' interest because he asked "How are your export sales?" or a second who sent birthday cards instead of Christmas cards is rather puerile. A neophyte salesman would learn more of the game of selling from a few evenings spent in the smoking room of a commercial hotel than by reading books of this type. V. C. F.

# Obituary

MR. ROBERT BROWNLIE, late of the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, died on November 10.

LT.-COL. SYDNEY CAMPBELL WRIGHT, managing director of C. & C. Wright (Boston), Limited, iron merchants, etc., of Boston, Lincs, died recently. He was 67.

MR. WILLIAM BENJAMIN THURSFIELD, who for 30 years had been in charge of the Kettering depot of Hall & Rice, Limited, ironfounders, of West Bromwich, died suddenly on November 5. He was 79.

MR. HERBERT HENRY ELVIN, of Stanmore, Middx, who died on November 9 at the age of 75, was chairman of the T.U.C. in 1937 and in 1938 became a member of the Royal Commission on the Geographical Distribution of the Industrial Population.

MR. WILLIAM SUMMERS, who died last week, was supervising engineer at the Middlesbrough works of Pease & Partners, Limited, pig-iron makers. He was an acknowledged authority on general ironworks practice and served on various Government advisory committees during the war period.

MR. HARRY MILLWARD, managing director of H. Millward (Metals), Limited, manufacturers of metal smallwares, etc., of Birmingham, died recently. He was 70. Mr. Millward joined the company at an early age and took charge of it 50 years ago upon the death of his father, who founded the undertaking in 1840.

MR. EDWARD PELLEW PLENTY, a director and formerly managing director of Plenty & Son, Limited, marine engineers, ironfounders, etc., of Newbury, Berks, died on Sunday. He was 81. Mr. Plenty was the great-grandson of the founder of the firm, which was established in 1790. He spent the whole of his working life with the company and even served his apprenticeship there.

## Call for Industrial Incentives

The policy of nationalisation, if persisted in, would bring disaster to our economic life and would be the death blow to that spirit of enterprise and adventure which had served us so well in the past, said Lord McGowan, chairman of Imperial Chemical Industries, Limited, in the course of the first of a winter series of free enterprise meetings organised by the National Union of Manufacturers at Birmingham. Our national planning since the war had, perhaps, made some contribution to orderly arrangement and progress, but it had been overlaid by false doctrine and had also led to frustration by excessive interference in detail.

Referring to the question of wage policy, Lord McGowan said that what was needed was not a wage structure guaranteeing a certain standard of living, but a wage policy of incentives and sanctions which would encourage the industrious and penalise the lazy. He would like to see the increasing use in every industry, where it was possible, of work measurement and piece rates as a method of wage payment. The true solution was not to increase production by working longer hours, but to obtain greater production from existing hours of work by greater effort.

# Company Results

*(Figures for previous year in brackets.)*

CARGO FLEET IRON COMPANY—Dividend of 5% (same).

F. H. LLOYD & COMPANY—Interim dividend of 3% (same).

HALE & HALE (TIPTON)—Final dividend of 15%, making 20% (same).

SOUTH DURHAM STEEL & IRON COMPANY—Dividend of 10% (same).

WOLVERHAMPTON METAL COMPANY—Interim dividend of 20% (same).

FLEMING & FERGUSON—Final dividend of 12½% (10%), making 17½% (15%). A tax-free distribution of 10% out of capital profits has also been paid.

LIGHTALLOYS—Net profit for the year ended June 26, £68,231 (£35,394); to directors' remuneration, £11,436 (£7,787); depreciation, £6,524 (£6,384); balance, £50,271 (£21,223 plus £2,702 E.P.T. recovered); to tax, £28,000 (£11,180); final dividend of 10%, making 15% (same); forward, £12,371 (£2,845).

REDPATH BROWN & COMPANY—Trading profit for the year ended July 31, £559,219 (£575,930); trade investment and miscellaneous income, £1,045 (£8,477); tax surplus, £40,472 (£34,875); to directors' emoluments, £11,171 (£11,626); auditors' remuneration, £735 (£853); depreciation, £30,000 (same); income tax, £269,742 (£206,448); other tax, £118,819 (£122,969); balance of profits, £170,269 (£247,396); brought in, £172,244 (same); net ordinary dividend (shares held by Dorman, Long & Company), £164,494 (£241,621); forward, £172,244.

JOHN SHAW & SONS, WOLVERHAMPTON—Consolidated trading profits and other income for the year ended June 30, £157,455 (£192,576); to depreciation, £23,009 (£28,706); bad-debts reserve, nil (£4,854); deferred repairs, £402 (£463); tax, £72,513 (£88,335); outside subsidiary profits, £616 (£636); undistributed subsidiary profits, £2,171 (£5,420); net profit of parent company, £58,744 (£64,162); brought in, £31,429 (£20,662, plus £817 bad-debts surplus and tax-reserve surplus of £15,000); subsidiary balances, £20,289 (£18,230); available, £110,462 (£118,871); to subsidiary preliminary expenses, nil (£112); general revenue reserve, £20,000 (same); dividend equalisation reserve, £10,000 (£20,000); pension scheme, £10,000 (£20,000); dividend of 10% (same); capital bonus of 5% not subject to tax (same); forward, £61,250.

# Contracts Open

*The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D. or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.*

DAGENHAM, January 7—Tools, implements, iron castings, etc., for the Borough Council. The Borough Engineer and Surveyor, Civic Centre, Dagenham.

CAERPHILLY, November 28—Provision and laying of about 3,500 yds. of 10-in., 9-in., 8-in., and 6-in. cast-iron pipes, etc., for the U.D.C. The Council Offices, Caerphilly. (Deposit, £5 5s.)

BELGIUM, November 30—A 75 KVA. transformer, for the Belgian State Railways. (Reference: C.R.E. (I.B.) 32625/49; Room 1091.)

GODALMING, December 3—Supplying and laying 2,500 yds. of 6-in. spun-iron water main, etc., for the Borough Council. Mr. C. B. Spivey, water engineer, Municipal Buildings, Bridge

## Students' Grants

The panel of assessors of the Institute of British Foundrymen to decide on the award of the Students' Grant for financial or practical assistance has chosen Mr. Brinley Edwards, of Beosham Foundry, Wrexham, North Wales, as the recipient. He has commenced a course of study at the National Foundry College, Wolverhampton.

## Personal

MR. JOHN CROZIER has been appointed a director of Scottish Agricultural Industries, Limited, agricultural engineers and chemical manufacturers, of Edinburgh.

MR. R. MCGILL, head foreman of Glenfield & Kennedy, Limited, hydraulic engineers and founders, of Kilmarnock, has retired after 51 years' service with the company.

MR. ARTHUR G. GILBERTSON, formerly with Richard Thomas & Baldwins, Limited, has been appointed a director of Brown, Lenox & Company, Limited, engineers and steelfounders, etc., of Pontypridd.

MR. T. H. B. WHITING, manager of the spares and service department of Aveling-Barford, Limited, manufacturers of road machinery, etc., of Grantham, has been appointed to the board of management of the company.

LORD EUSTACE PERCY has been awarded a diploma of honorary fellowship of the North-East Coast Institution of Engineers and Shipbuilders in recognition of his services to higher education as Rector of King's College, Newcastle-upon-Tyne.

MR. N. G. LANCASTER, who was elected to the board of Tube Investments, Limited, last April, has been appointed an assistant managing director. SIR GEOFFREY BURTON has been elected to the board of the new subsidiary company, TI Cycles (South Africa), Limited.

MR. J. D. THORN has been appointed chief research engineer to Ruston & Hornsby, Limited, Lincoln, following the resignation of MR. C. H. BRADBURY. Mr. Thorn will be responsible for the technical direction of research and development work on oil engines, gas turbines, locomotives, etc.

MR. E. JULIAN PODE, managing director, and MR. DAVID J. YOUNG, secretary, of the Steel Company of Wales, Limited, are at present in America on a visit to the United Engineering & Foundry Company, Pittsburgh, which is making the machinery for the new Abbey Works at Margam.

## The Schnadt Impact Test

Mr. Henri M. Schnadt has accepted an invitation to visit this country to address a meeting of the Institute of Welding on November 30, at the Institution of Civil Engineers, Great George Street, London, S.W.1, at 6 p.m.

Mr. Schnadt is a Belgian engineer, well known in continental countries for a new system of impact testing which he has introduced. While Mr. Schnadt's theories are still the subject of lively controversy, his testing technique is finding increasing application on the continent in the steel-using and steel-producing industries. The Schnadt test offers certain advantages, for it permits the testing of adjacent zones separately, and it has been adopted also for determining the notch sensitivity of constructional steels, a problem which has been important to engineers for some years.

The Council of the Institute of Welding have invited Mr. Schnadt to this country in order to give engineers and metallurgists an opportunity to obtain first-hand information on his work.

## Selected Government Research Reports

During the war, much scientific and technical research was carried out in Government laboratories and research stations and by Universities and firms on behalf of His Majesty's Government. Most of this work had a direct bearing on the war effort and for obvious reasons could not be publicly disclosed at the time. It has long been realised, however, that many of the results of this research might be used with advantage to further the drive for greater productivity in peacetime industry. For this reason, the large quantity of material involved is being sifted with the object of selecting and publishing those reports which are considered to be of primary interest to industry or of value to research scientists. The Ministry of Supply and the Technical Information and Documents Unit of the Board of Trade are now engaged in preparing a series of volumes of selected reports. Each volume, containing a number of individual reports, is concerned with one particular subject, and it is hoped that the whole series will eventually cover a wide industrial field. Volume 2, on "Paints," which can be obtained from H.M. Stationery Office, Kingsway, London, W.C.2, and branches, price 5s. net (5s. 3d. by post), contains eight reports. Three of the reports are concerned with the protection of magnesium alloys. The effect of seawater corrosion on various treated surfaces is discussed, and tests are described on the inclusion of a fungicide in the paint. Another report describes investigations made on temperature-sensitive paints. Other subjects include the surface treatment of brass, especially in optical equipment, and the determination of the viscosity of paints. Further titles in the series will include: Protection and electrodeposition of metals; strength and testing of materials; and powder metallurgy.

## Mechanical Handling Exhibition, 1950

The provisional programme of subjects to be discussed at the Second Mechanical Handling Exhibition and Convention at Olympia, London, from June 6 to 17, 1950, is now announced. The Convention, which was first held very successfully in 1948, is expected to be of particular interest to visiting buyers and is intended to promote the technique of mechanical handling as applied to production. There will be 800 seats in the convention hall in the gallery of the National Hall, Olympia, and tickets, available on application beforehand, will be free. In another hall in the gallery, films will be shown. The whole of the exhibits will be on the ground-floor level of the Grand and National halls, Olympia. Exhibits will cover the full range of equipment for the handling, lifting, stacking, and short-distance transportation of goods.

The following associations are co-operating with the organisers:—The Aerial Ropeways Association, the Association of Crane Makers, the Foundry Trades' Equipment & Supplies Association, Limited, the Industrial Truck Manufacturers' Association, and the Mechanical Handling Engineers' Association.

# Company News

The paragraphs below have been extracted from statements circulated to shareholders, speeches made at annual meetings, and other announcements.

**Shotts Iron Company, Limited:**—The directors propose to repay £397,650 capital no longer required in the company's business. The proposals provide for the repayment in full at par of the 115,665 5 per cent. £1 cumulative preference and 20,439 5 per cent. £1 second cumulative preference and repayment of 10s. per £1 share on the £523,093 ordinary. The unissued 4,335 cumulative preference are to be cancelled and upon the scheme being confirmed by Court the 136,468 unissued shares of £1 each are to be divided into 10s. shares and the capital of the company increased to its original amount of £800,000 by the creation of 803,971 shares of 10s. each. Interest on the preference and second preference at 5 per cent., less tax, will be calculated up to the date of repayment. Similar proposals were submitted in November, 1947, but the directors decided to delay capital repayment pending decisions under Section 25 of the Coal Industry Nationalisation Act, 1946, regulations. Following upon recent decisions in the House of Lords counsel's opinion was obtained and the directors have decided to proceed with the proposals. A meeting is to be held on December 7 to consider resolutions dealing with the proposals.

**Amalgamated Metal Corporation, Limited:**—By the judgment of the Federal Court of Switzerland the company has been awarded, as purchase price for the 6,120 shares in Metallgesellschaft, £300,000 payable by the Société Suisse pour Valeurs de Metaux of Basle. Payment will be received in the course of the next few weeks. The directors state that owing to a bonus issue of Metallgesellschaft shares in 1942, the corporation's shareholding was increased from 6,120 to 9,180 shares. The judgment now reported is in respect of 6,120 shares only so that company retains 3,060 shares. While somewhat disappointed by the award of £300,000, the directors are reasonably satisfied with the outcome of the case, and believe that the shares retained in Metallgesellschaft will one day prove to be of considerable value.

**Redpath Brown & Company, Limited,** structural engineers and iron and steel stockholders, of Edinburgh:—The directors state that taxation is levied on profits accrued on uncompleted contracts, although the company only takes into the accounts the result of contracts when they have been completed. Owing to a substantial increase in the volume of contracts uncompleted at the date of the accounts, the charge for taxation is out of proportion to the published profits. Production was slightly in excess of that of the previous year. Orders in hand for the current year are satisfactory and include substantial tonnages for home contracts of national importance and many projects abroad.

**Henry Norrington & Son, Limited,** agricultural implement makers and ironfounders, of Exeter (MR. G. LAMBERT):—Referring to a resolution which was passed to increase the authorised share capital so that the directors could, if they thought it advisable, increase the issued capital, he states that considerable thought has been given to schemes for such an increase, but the board has decided, in view of the adequate bank facilities and the present difficult conditions, not to proceed with any issue of shares at present. If, however, the occasion should arise shareholders' interests will be kept paramount.

**Lightalloys, Limited** (MR. J. C. COLQUHOUN):—The order-book is being maintained at a satisfactory level and no change in the volume of business of any significance is in sight. Any general improvement in the country's export business resulting from devaluation of the £ should benefit the business to the extent that a substantial part of the output goes indirectly into exports. Also, although the order-book is well filled, the orders are spread over a considerable period and we have, therefore, available capacity for an increase in the current rate of production.

# Parliamentary

## Accidents at Ironfoundries

MR. M. MACPHERSON asked the Minister of Labour, in view of the high accident rate in the ironfounding industry, as noted by the Chief Inspector of Factories in his annual report, what steps were being taken to bring this rate down.

MR. ISAACS, in reply, said that the steps taken by his department to try and reduce the number of accidents included the promotion of safety education so as to obtain the co-operation of the workers in various matters, such as the maintenance of a high standard of tidiness and good order in the foundry. Among other things, the wearing of special safety boots and leg protection against the risk of burns from molten metal was recommended. The Joint Standing Committee on Conditions in Ironfoundries recently agreed that accident prevention should be included among the matters which they would keep under constant review. The Minister said he was advised that most of the accidents in ironfoundries either related to persons falling or arose in connection with the handling of goods or from splashes of molten metal.

## Steel Production Capacity

MR. SCOTT-ELLIOT, who asked the Minister of Supply if he would give an estimate of how much additional capacity was likely to become available during 1950 for the manufacture of those types of steel now in short supply, was told by MR. STRAUSS that no additional finishing capacity for the manufacture of those types of steel now in short supply would become available until 1951, but improved supplies of raw material for existing finishing capacity would lead to some increase in production of sheet and wire in 1950.

# STANTON-DALE

## REFINED PIG IRON

Designed to meet the demands of high quality castings, which are, strength, machineability, and resistance to wear.

All these can be secured by using Stanton-Dale Refined Pig Iron in your cupolas.

The above illustration shows a group of castings made by Messrs. Goodbrand & Co. Ltd., Stalybridge, Cheshire.

## PROMPT DELIVERY

**THE STANTON IRONWORKS COMPANY LIMITED NEAR NOTTINGHAM**

# Raw Material Markets

## Iron and Steel

It is probable that the current output of iron castings exceeds the volume of new orders reaching the foundries. Certainly, confidence has been seriously undermined and the tone of the market is hesitant. Available tonnages of all grades of pig-iron are not in excess of requirements and consumers are taking up their allocations; but there is no longer any pressure to secure iron for stock. Refined-iron makers are in a position to offer prompt deliveries to home consumers and are handling a few small orders for shipment overseas. On the other side of the account, imports of pig-iron from the Continent are rapidly dwindling.

The intensification of foreign competition for business in re-rolled steel products and the overall shrinkage in demand is reflected in the quiet state of the market for semis. The supply of billets is more than adequate to satisfy all requirements, but the strength of the market for slabs and sheet bars is unimpaired. The sheet trade is immune from the depressing influences of the declining demand which has become evident in other branches of the steel industry and the call for sheets is maintained at a high level.

Plate mills have sufficient orders in hand to ensure capacity production for several months ahead and, indeed, it becomes increasingly apparent that all the orders authorised for Period IV cannot possibly be fulfilled. Rail mills, too, are heavily engaged, and the volume of export orders which the sheetmakers are permitted to handle is severely limited owing to the extent and the urgency of home requirements. A further complication is that Canadian orders for sheets cannot be fulfilled immediately owing to difficulties of shipment during the freeze-up of the St. Lawrence.

## Non-ferrous Metals

Dealing on the newly-opened tin market made a quiet start and has continued on a fairly subdued scale. Day by day, however, there has been a steady business passing and the turnover for the four days' operation last week was by no means insignificant. On the first day (November 15) cash tin closed at £725 to £726, and forward at £660 to £669, but by Friday values had fallen away to £675 (cash) and £592 10s. (three months). Thus in a matter of a few days the free market registered a fall for the forward position of about £160 per ton on the Ministry of Supply's price of £750.

However, the important thing is that the free market in tin has been launched and matters have worked out on the whole very well. The backwardation is certainly unnaturally large, but with such big stocks on hand, it is obvious that the Government was obliged to hold back for fear of overwhelming the market with more metal than it could conveniently and safely absorb. Alternatively, values would have slumped catastrophically.

Metal Exchange tin quotations were as follow:—

*Cash*—Thursday, £690 to £695; Friday, £675 to £680; Monday, £662 10s. to £665; Tuesday, £642 10s. to £645; Wednesday, £640 to £645.

*Three Months*—Thursday, £617 to £620; Friday, £592 10s. to £600; Monday, £582 10s. to £585; Tuesday, £592 10s. to £597 10s.; Wednesday, £595 to £599.

The publication of October statistics by the Copper Institute in New York confirmed the view that deliveries in America last month were on a good scale. The total was 108,192 short tons, against 103,115 tons in the preceding month. Production of crude copper in October was 69,061 short tons, against 64,237 tons in September, the corresponding figures in the refined quality being 86,882 short tons and 79,949 tons. Stocks, as might be expected, fell from 193,890 short tons at September 30, to 164,464 short tons at the end of October.

As a result of a setback of 25 points in the U.S. lead price, the U.K. quotation declined last Thursday by £2 per ton to £103, and on Monday the Ministry of Supply made a further reduction of £2 to £101 per ton. Yesterday (Wednesday) the price was again cut, this time by £4 to £97 a ton. The Ministry has also reduced the zinc price by £2 to £85 10s. a ton and zinc oxide, in lots of not less than 2 tons, by £1 15s. a ton.

At the end of last week lead scrap in New York was quoted 25 points lower at 9.25 to 9.50 cents. per lb. Scrap prices in Britain are well maintained and the Ministry of Supply is believed to be quite satisfied with the quotations received for its surplus disposals of brass and copper.

## Records being Broken

The Council of Ironfoundry Associations, in General Bulletin No. 48, report that the output of iron castings in the third quarter of this year amounted to 793,039 tons, made up of 765,268 tons of grey iron and 27,771 tons of malleable-iron castings. The total is almost 15,000 tons larger than the output of the corresponding period of last year. For the first nine months of 1949, production amounted to 2,520,021 tons, equal to a yearly production rate of 3,360,028 tons. The total output for 1948, it will be remembered, was 3,283,901 tons.

LORD CALVERLEY performed the opening ceremony on Saturday at the "Keighley for Britain" exhibition at Keighley Drill Hall, at which the principal products of the district are on show for a week.

THE NATIONAL BRASSFOUNDRY ASSOCIATION held a luncheon party in Birmingham last week at which a bronze plaque was presented to Agar, Bates, Neal & Company, accountants, of Edmund Street, Birmingham, which for 51 years has been the Association's accountants. The presentation was made by the president, Mr. H. W. Blake, to Mr. David Neal.